Health Canada Santé Canada

2003 Report on Occupational Radiation Exposures in Canada

Canada

2003 Report on Occupational Radiation Exposures in Canada

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Abstract

The report provides statistics on occupational radiation exposures for use by regulatory authorities, organizations and private individuals. Out of a total of 136,050 monitored workers, 3 annual doses exceeded the regulatory limit of 50 mSv in 2002. Out of 58 specified job categories, 25 had a smaller annual average in 2002 than in 2001, 29 had a higher average, and 4 had the same average rounded to 0.01 mSv. Typically, the changes in average dose were small.

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Introduction

This series of reports provides statistics on occupational radiation exposures of monitored workers in Canada. The statistics are intended to assist regulatory authorities, organizations, and private individuals in comparing incurred occupational radiation exposures with national or provincial/territorial averages and trends in similar occupations. This report, as well as previous issues, can be found on the NDR's web site[1] and downloaded, or obtained from the authors.

The information is based on the data in the National Dose Registry (NDR) maintained by the Radiation Protection Bureau of Health Canada[1]. The Registry is a centralized record-keeping system containing dose information on all monitored workers in Canada. It includes data submitted by nuclear power generating stations, Atomic Energy of Canada Ltd., uranium mines, and dosimeter processing companies.

Information for input into the NDR is received either via a direct link or by mail in computer readable form.

The report provides data on the two consecutive years prior to the year in which the data are extracted from the database. The data for the second (i.e. more recent) year will be close to complete at the time of data extraction. Some changes may still occur, for which the most frequent causes are: (1) a high dose to a dosimeter is judged to be non-personal after investigation; (2) a job category of a worker is updated; or, (3) dosimeters or data are returned late. The report therefore contains preliminary data on the second year (Table 1), and more complete data on the first year (Tables 2-4).

For a description and a guide to interpretation of the data, the reader is referred to the next section "General comments". The section "Comments specific to this report" has been included to address situations that do not recur from year to year.

General comments

The statistics include doses as they exist in the database at the time they are extracted for analysis, which in the case of this report is July 19, 2003. Doses are assigned to the year in which the dosimeter was issued, even though some of the dosimeters may actually have been worn during part of the subsequent year. As the statistics are determined in the same manner each year, the annual dose figures are based on a 12-month period, though not necessarily the strict calendar year.

Dose records submitted by outside organizations such as nuclear power generating stations, uranium mines, and commercial processors, are included to the extent that they have been received. The doses are representative of the calendar year only if the fourth quarter records have been received by the time of analysis. When statistics are based on partial data, the fact is indicated in the section "Comments specific to this report".

All doses are in International System (SI) units and presented to the nearest hundredth of a millisievert (1 mSv = 100 mrem). For the external whole body doses various organizations have set recording thresholds from 0 to 0.2 mSv.

The words "dose" and "exposure" are used interchangeably in this report. Doses of different types of radiation are expressed in mSv and added to give the effective dose stated in the report. The following dose types may be included:

- External whole body gamma.
- External whole body high energy beta.
- External whole body X-ray.
- External whole body neutron.
- Internal whole body tritium, as determined by urinalysis.
- Radon progeny exposures, converted from WLM values (see below).

All types of exposure are given in one total. In Tables 3 and 4, the percentage contribution of radon progeny and tritium components are indicated for occupations related to mining and nuclear power generation, respectively. Skin doses and extremity doses are not included in the report but are recorded in the database.

In the NDR database, radon progeny exposures are expressed in Working Level Months (WLM), which are in most cases calculated by the mines on the basis of area monitoring[2]. In the report the radon progeny exposures are converted to equivalent doses (in mSv). The value used in this report is 5 mSv/WLM, in accordance with the radiation protection regulations[3] under the Nuclear Safety and Control Act, which came into force on May 31, 2000.

Job category designations are based on a standard list provided by the Registry and are updated when the Registry is notified. The job category is selected by the organization from a standard list maintained by the NDR. The NDR keeps the most recent job category that an organization submits for a worker in a given year. However, a worker who has been monitored by more than one organization, can have records under more than one job category for the same year. Some organizations have their own job classifications schemes, and translate them into the Registry's standardized list prior to submission of the records.

In this report, the data are tabulated as follows:

2002: Preliminary analysis

Table 1:

Table 1 gives the annual dose distributions by job category.

2001: Final Analysis

Table 2:

Table 2 contains dose statistics by job category and province or territory.

Table 3:

Table 3 contains dose statistics by age and sex. In this table job categories have been grouped into "job sectors".

Table 4:

Table 4 contains various dose statistics by job category. The table also shows the parameters of the statistical distribution applied to the doses, as determined by maximum likelihood estimation. From that information, it is possible to calculate estimates and confidence intervals of statistics of the distribution. For a more detailed discussion the reader is referred to the Appendix.

Table 4 also includes an accumulated dose distribution over the 5 year period 1997-2001 for the workers under the given job category.

Finally, Table 4 contains a histogram that shows the trend in average annual doses over the period 1992-2001.

It should be noted that in the tables, a worker is counted more than once if he (she) works in more than one job category, in more than one province, or in more than on job sector in the same year. For this reason the totals in Tables 2-4 may slightly differ.

Comments specific to this report

A new dose distribution has been designed and used to model dose data. One can obtain dose estimates from the parameters listed in table 4 using numerical integration. In most cases it is necessary to divide the interval of integration into sections that are small enough for standard numerical integration routines to give accurate results. Details are given in the Appendix. Software has been written to calculate estimates and their confidence intervals. A release version is not available at this time.

References

1. The National Dose Registry's web site is found at http://www.hc-sc.gc.ca/ndr .

2. ICRP publication 65, "Protection against Radon-222 at home and at work.", Annals of the ICRP 23(2), p.4 (1993).

3. Regulations of the *Nuclear Safety and Control Act*, Canada Gazette, June 21, 2000, part 2. For more information see the web site of the CNSC:

   http://www.nuclearsafety.gc.ca

   or see:

   http://laws.justice.gc.ca/en/N-28.3/SOR-2000-203/152993.html

4. Kumazawa, S. and Numakunai, T. "A new theoretical analysis of occupational dose distributions indicating the effect of dose limits.", Health Physics 41(3) pp. 465-475 (1981).

2002 Preliminary Analysis

Table 1
Breakdown of annual doses by job category for all of Canada

Job Category	Distribution of workers over dose intervals							Number of Workers	Avg. Dose (mSv)	Avg. of Positive Doses
	0 mSv	>0-1 mSv	>1-2 mSv	>2-5 mSv	>5-20 mSv	>20-50 mSv	>50 mSv			
Administration										
Administrator	384	191	1	3	0	0	0	579	0.14	0.43
Office staff	3251	495	13	2	1	0	0	3762	0.05	0.34
Safety officer	144	52	4	3	1	0	0	204	0.20	0.69
Industry and Research										
Industrial radiographer	1245	543	217	380	471	27	1	2884	2.48	4.36
Instructor (non-medical)	164	22	1	0	0	1	0	188	0.18	1.41
Instrument technician	1641	485	30	34	10	0	0	2200	0.17	0.68
Laboratory technician (industrial)	3032	911	64	97	18	1	0	4123	0.20	0.76
Nuclear fuel processor	134	250	95	101	66	0	0	646	1.67	2.11
Scientist/Engineer (field)	658	534	32	16	3	0	0	1243	0.24	0.50
Scientist/Engineer (laboratory)	5311	1187	22	12	3	1	0	6536	0.06	0.31
Tradesmen	85	30	3	0	0	0	0	118	0.13	0.45
Well logger	688	496	85	39	10	0	0	1318	0.38	0.79
Medicine										
Chiropractor	942	73	2	2	0	0	0	1019	0.03	0.38
Dental assistant	11340	339	11	1	0	0	0	11691	0.01	0.26
Dental hygienist	8149	213	2	2	0	0	0	8366	0.01	0.25
Dental therapist/nurse	112	11	0	0	0	0	0	123	0.03	0.29
Dentist	7051	224	8	1	1	1	1	7287	0.04	1.36
Gynaecologist	8	3	0	0	0	0	0	11	0.04	0.14
Laboratory technician (medical)	2827	457	30	36	17	0	0	3367	0.11	0.71
Medical physicist	284	58	0	2	0	0	0	344	0.06	0.32
Medical radiation technologist	9598	2739	114	84	10	1	0	12546	0.10	0.42
Nuclear medicine technologist	298	416	311	484	58	0	0	1567	1.66	2.04
Nurse	4270	1231	68	15	4	0	0	5588	0.10	0.41
Physician	1520	611	67	33	7	1	0	2239	0.20	0.63
Radiation therapist	1081	496	14	11	2	1	1	1606	0.20	0.60
Radiologist (diagnostic)	1505	426	29	19	7	0	0	1986	0.14	0.60
Radiologist (therapeutic)	191	48	2	2	1	0	0	244	0.12	0.56
Veterinarian	3063	529	24	4	1	0	0	3621	0.05	0.35
Veterinary technician	1878	267	16	0	0	0	0	2161	0.04	0.33
Ward aid/orderly	1247	167	9	7	1	0	0	1431	0.06	0.48

Table 1 (Cont'd)
Breakdown of annual doses by job category for all of Canada

Job Category	Distribution of workers over dose intervals							Number of Workers	Avg. Dose (mSv)	Avg. of Positive Doses
	0 mSv	>0-1 mSv	>1-2 mSv	>2-5 mSv	>5-20 mSv	>20-50 mSv	>50 mSv			
Nuclear Power										
Reactor - administration	3891	428	75	81	35	0	0	4510	0.16	1.15
Reactor - chemical and radiation control	142	171	49	52	52	0	0	466	1.68	2.42
Reactor - construction	905	379	157	184	211	5	0	1841	1.64	3.22
Reactor - control technician	83	57	15	15	20	0	0	190	1.35	2.40
Reactor - electrical maintenance	651	465	125	139	62	0	0	1442	0.86	1.57
Reactor - fuel handling	4	10	5	15	17	0	0	51	3.99	4.33
Reactor - general maintenance	936	318	69	124	70	0	0	1517	0.77	2.00
Reactor - health physics	31	20	3	8	0	0	0	62	0.69	1.38
Reactor - industrial radiographer	9	21	5	14	17	0	0	66	2.92	3.38
Reactor - mechanical maintenance	627	463	147	261	237	0	0	1735	1.84	2.89
Reactor - operations	834	828	215	205	107	0	0	2189	0.97	1.57
Reactor - scientific/professional	1829	394	92	121	83	0	0	2519	0.54	1.97
Reactor - training	41	6	4	5	2	0	0	58	0.56	1.90
Reactor - visitor	4442	1171	337	394	257	4	0	6605	0.68	2.06
Uranium Mining										
Uranium mine electrician	6	1	0	0	0	0	0	7	0.01	0.10
Uranium mine mill maintenance	15	95	41	30	2	0	0	183	1.08	1.17
Uranium mine mill worker	40	78	53	57	13	0	0	241	1.58	1.89
Uranium mine nurse	7	4	0	0	0	0	0	11	0.08	0.23
Uranium mine office staff	93	70	1	0	0	0	0	164	0.10	0.23
Uranium mine support worker	29	55	20	36	3	0	0	143	1.25	1.56
Uranium mine surface maintenance	28	166	18	1	0	0	0	213	0.46	0.53
Uranium mine surface miner	23	13	8	9	4	0	0	57	1.22	2.05
Uranium mine surface personnel	70	137	20	1	0	0	0	228	0.33	0.47
Uranium mine surface support worker	167	164	11	1	0	0	0	343	0.18	0.34
Uranium mine underground maintenance	11	88	26	9	0	0	0	134	0.68	0.74
Uranium mine underground miner	14	78	45	50	24	0	0	211	1.98	2.12
Uranium mine underground personnel	25	61	13	6	0	0	0	105	0.62	0.82
Uranium mine visitor	68	111	3	0	0	0	0	182	0.12	0.20
Miscellaneous/Unknown										
Miscellaneous/unknown	20091	6239	424	271	106	8	0	27139	0.16	0.62

Table 2
Number of workers (top) and average whole body dose in mSv (bottom) by job category and province/territory

Job Sector and Category	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Administration													
Administrator	3	0	8	6	67	392	15	6	49	33	1	0	580
	0.00	0.00	0.03	0.04	0.02	0.18	0.00	0.00	0.06	0.02	0.00	0.00	0.13
Office staff	51	8	94	60	649	2053	262	86	354	275	12	2	3906
	0.12	0.00	0.01	0.02	0.01	0.06	0.01	0.01	0.06	0.01	0.00	0.00	0.05
Safety officer	4	1	7	4	30	89	14	7	23	12	0	0	191
	0.30	0.60	0.01	0.00	0.01	0.12	0.03	0.10	0.10	1.05	0.00	0.00	0.15
OVERALL	**58**	**9**	**109**	**70**	**746**	**2534**	**291**	**99**	**426**	**320**	**13**	**2**	**4677**
	0.13	**0.07**	**0.01**	**0.02**	**0.01**	**0.09**	**0.01**	**0.01**	**0.06**	**0.05**	**0.00**	**0.00**	**0.06**
Industry and Research													
Industrial radiographer	67	0	78	117	386	657	35	180	1187	255	1	4	2967
	0.23	0.00	0.72	2.02	1.29	1.48	0.60	1.83	5.03	2.11	0.00	0.03	2.91
Instructor (non-medical)	9	4	19	3	29	44	7	22	32	18	1	0	188
	0.00	0.00	0.02	0.09	0.02	0.01	0.00	0.03	0.09	0.01	0.00	0.00	0.03
Instrument technician	87	1	189	55	464	1114	58	44	204	85	2	0	2303
	0.20	0.50	0.09	0.09	0.11	0.80	0.01	0.05	0.12	0.04	0.00	0.00	0.44
Laboratory technician (industrial)	56	12	60	55	1015	2026	258	395	331	187	0	0	4395
	0.13	0.04	0.02	0.05	0.07	0.39	0.07	0.03	0.05	0.06	0.00	0.00	0.21
Nuclear fuel processor	0	0	0	0	0	601	0	0	2	0	0	0	603
	0.00	0.00	0.00	0.00	0.00	1.34	0.00	0.00	0.24	0.00	0.00	0.00	1.33
Scientist/Engineer (field)	31	0	25	51	58	792	14	53	128	106	10	0	1268
	0.22	0.00	0.01	0.35	0.03	0.32	0.00	0.02	0.27	0.09	0.05	0.00	0.25
Scientist/Engineer (laboratory)	95	3	143	18	2157	2058	147	117	893	748	0	0	6379
	0.03	0.10	0.04	0.08	0.02	0.30	0.01	0.02	0.12	0.03	0.00	0.00	0.13
Tradesmen	0	0	0	1	5	80	1	5	6	4	0	0	102
	0.00	0.00	0.00	0.00	0.06	0.11	0.00	0.02	0.22	0.00	0.00	0.00	0.11
Well logger	0	0	0	1	1	4	0	41	1275	11	1	0	1334
	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.03	0.44	0.22	0.00	0.00	0.43
OVERALL	**345**	**20**	**514**	**301**	**4115**	**7376**	**520**	**857**	**4058**	**1414**	**15**	**4**	**19539**
	0.14	**0.06**	**0.16**	**0.88**	**0.16**	**0.59**	**0.08**	**0.41**	**1.66**	**0.42**	**0.03**	**0.03**	**0.67**
Medicine													
Chiropractor	4	1	4	3	496	294	77	14	123	26	0	0	1042
	0.03	0.00	0.00	0.00	0.03	0.04	0.04	0.02	0.04	0.06	0.00	0.00	0.03
Dental assistant	141	40	318	160	2542	5531	744	322	1018	648	28	3	11495
	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.01
Dental hygienist	53	22	201	116	2811	3630	477	145	403	323	7	4	8192
	0.01	0.02	0.01	0.01	0.04	0.01	0.00	0.01	0.02	0.01	0.00	0.10	0.02
Dental therapist/nurse	0	0	0	0	10	18	24	36	8	3	9	8	116
	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.02	0.03	0.01
Dentist	106	12	151	102	2800	2877	529	117	371	255	24	3	7347
	0.02	0.07	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.02	0.00	0.01
Gynaecologist	1	0	2	0	3	3	3	0	0	1	1	0	14
	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Table 2 (Cont'd)
Number of workers (top) and average whole body dose in mSv (bottom) by job category and province/territory

Job Sector and Category	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Laboratory technician (medical)	40	1	145	10	1200	1112	129	63	195	288	4	2	3189
	0.00	0.30	0.01	0.07	0.06	0.09	0.03	0.06	0.17	0.04	0.00	0.00	0.07
Medical physicist	2	2	11	5	109	105	17	12	9	66	1	0	339
	0.20	0.00	0.05	0.12	0.03	0.55	0.11	0.04	0.03	0.01	0.00	0.00	0.19
Medical radiation technologist	305	58	203	308	3020	4439	567	706	1319	1402	31	11	12369
	0.06	0.09	0.06	0.09	0.08	0.08	0.03	0.09	0.10	0.07	0.06	0.03	0.08
Nuclear medicine technologist	20	6	45	32	492	577	68	20	111	182	0	0	1553
	2.02	0.52	1.83	1.48	1.82	1.40	1.15	1.90	1.24	0.69	0.00	0.00	1.45
Nurse	198	5	142	155	1180	2444	322	82	215	415	122	73	5353
	0.05	0.00	0.08	0.15	0.04	0.11	0.01	0.19	0.20	0.12	0.01	0.04	0.09
Physician	46	5	58	28	705	897	68	31	159	185	3	3	2188
	0.03	0.04	0.06	0.19	0.15	0.20	0.04	0.28	0.19	0.11	0.00	0.00	0.16
Radiation therapist	21	4	42	17	311	697	47	76	75	268	0	0	1558
	1.33	0.00	0.13	0.05	0.18	0.06	0.12	0.08	0.08	0.04	0.00	0.00	0.10
Radiologist (diagnostic)	54	7	32	43	529	745	64	60	175	225	6	0	1940
	0.08	0.10	0.17	0.04	0.12	0.15	0.02	0.25	0.28	0.10	0.00	0.00	0.14
Radiologist (therapeutic)	2	3	6	10	73	96	11	4	0	31	0	0	236
	0.15	0.00	0.08	0.03	0.23	0.12	0.00	0.47	0.00	0.00	0.00	0.00	0.13
Veterinarian	42	52	170	77	813	1068	197	173	657	610	0	10	3869
	0.01	0.09	0.02	0.06	0.01	0.04	0.01	0.02	0.03	0.04	0.00	0.00	0.03
Veterinary technician	24	5	80	37	382	571	116	68	316	393	0	6	1998
	0.03	0.02	0.04	0.02	0.01	0.04	0.01	0.02	0.03	0.03	0.00	0.00	0.03
Ward aid/orderly	18	8	20	36	757	244	111	25	36	96	9	4	1364
	0.04	0.18	0.02	0.00	0.06	0.06	0.00	0.16	0.16	0.02	0.00	0.00	0.05
OVERALL	**1077**	**231**	**1630**	**1139**	**18233**	**25348**	**3571**	**1954**	**5190**	**5417**	**245**	**127**	**64162**
	0.10	**0.08**	**0.08**	**0.10**	**0.09**	**0.08**	**0.04**	**0.09**	**0.10**	**0.07**	**0.02**	**0.03**	**0.08**
Nuclear Power													
Reactor - administration	0	0	0	287	435	3945	0	0	0	0	0	0	4667
	0.00	0.00	0.00	0.08	0.11	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.19
Reactor - chemical and radiation control	0	0	0	29	30	363	0	0	0	0	0	0	422
	0.00	0.00	0.00	0.29	1.20	1.57	0.00	0.00	0.00	0.00	0.00	0.00	1.46
Reactor - construction	0	0	0	0	79	1998	0	0	0	0	0	0	2077
	0.00	0.00	0.00	0.00	0.05	1.71	0.00	0.00	0.00	0.00	0.00	0.00	1.65
Reactor - control technician	0	0	0	0	174	1	0	0	0	0	0	0	175
	0.00	0.00	0.00	0.00	0.84	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.83
Reactor - electrical maintenance	0	0	0	65	46	1220	0	0	0	0	0	0	1331
	0.00	0.00	0.00	0.41	2.08	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.99
Reactor - fuel handling	0	0	0	30	17	0	0	0	0	0	0	0	47
	0.00	0.00	0.00	3.11	3.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.17
Reactor - general maintenance	0	0	0	183	69	1250	0	0	0	0	0	0	1502
	0.00	0.00	0.00	0.29	2.49	1.06	0.00	0.00	0.00	0.00	0.00	0.00	1.03
Reactor - health physics	0	0	0	35	20	8	0	0	0	0	0	0	63
	0.00	0.00	0.00	0.74	0.09	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.47
Reactor - industrial radiographer	0	0	0	1	10	34	0	0	0	0	0	0	45
	0.00	0.00	0.00	7.32	2.30	1.16	0.00	0.00	0.00	0.00	0.00	0.00	1.55
Reactor - mechanical maintenance	0	0	0	120	167	1271	0	0	0	0	0	0	1558
	0.00	0.00	0.00	0.97	2.17	2.28	0.00	0.00	0.00	0.00	0.00	0.00	2.17

Table 2 (Cont'd)
Number of workers (top) and average whole body dose in mSv (bottom) by job category and province/territory

Job Sector and Category	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Reactor - operations	0	0	0	120	115	1935	0	0	0	0	0	0	2170
	0.00	0.00	0.00	0.55	1.08	1.18	0.00	0.00	0.00	0.00	0.00	0.00	1.14
Reactor - scientific/professional	0	0	0	382	254	1827	0	0	0	0	0	0	2463
	0.00	0.00	0.00	0.21	0.30	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.45
Reactor - training	0	0	0	34	30	0	0	0	0	0	0	0	64
	0.00	0.00	0.00	0.41	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36
Reactor - visitor	0	0	0	0	865	4276	0	0	0	0	0	0	5141
	0.00	0.00	0.00	0.00	0.03	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.59
OVERALL	**0**	**0**	**0**	**1286**	**2311**	**18128**	**0**	**0**	**0**	**0**	**0**	**0**	**21725**
	0.00	**0.00**	**0.00**	**0.40**	**0.51**	**0.91**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.84**
Uranium Mining													
Uranium mine electrician	0	0	0	0	0	0	0	3	0	0	0	0	3
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.10
Uranium mine mill maintenance	0	0	0	0	0	0	0	159	0	0	0	0	159
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.00	0.00	0.00	0.00	1.40
Uranium mine mill worker	0	0	0	0	0	0	0	239	0	0	0	0	239
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92	0.00	0.00	0.00	0.00	1.92
Uranium mine nurse	0	0	0	0	0	0	0	14	0	0	0	0	14
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.05
Uranium mine office staff	0	0	0	0	0	0	0	177	0	0	0	0	177
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.11
Uranium mine support worker	0	0	0	0	0	0	0	176	0	0	0	0	176
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.00	1.11
Uranium mine surface maintenance	0	0	0	0	0	0	0	189	0	0	0	0	189
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.57
Uranium mine surface miner	0	0	0	0	0	0	0	47	0	0	0	0	47
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.15	0.00	0.00	0.00	0.00	2.15
Uranium mine surface personnel	0	0	0	0	0	17	0	191	0	0	0	0	208
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.58
Uranium mine surface support	0	0	0	0	0	0	0	345	0	0	0	0	345
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.26
Uranium mine underground	0	0	0	0	0	0	0	115	0	0	0	0	115
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.46
Uranium mine underground miner	0	0	0	0	0	0	0	161	0	0	0	0	161
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.29	0.00	0.00	0.00	0.00	2.29
Uranium mine underground	0	0	0	0	0	4	0	73	0	0	0	0	77
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.46
Uranium mine visitor	0	0	0	0	0	1	0	101	0	0	0	0	102
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35
OVERALL	**0**	**0**	**0**	**0**	**0**	**22**	**0**	**1990**	**0**	**0**	**0**	**0**	**2012**
	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.91**	**0.00**	**0.00**	**0.00**	**0.00**	**0.90**

2001 Final Analysis

Table 3

Dose distribution broken down by job sector, age and sex.

			Sex			
Job Sector	Age	Statistic	Male	Female	Unknown	Overall
Administration	Below 25	Number of Workers	17	326	0	343
		Average dose (mSv)	0.15	0.01	0.00	0.01
	25-34	Number of Workers	98	941	0	1039
		Average dose (mSv)	0.24	0.02	0.00	0.04
	35-44	Number of Workers	253	1232	0	1485
		Average dose (mSv)	0.21	0.04	0.00	0.07
	45-54	Number of Workers	259	1064	0	1323
		Average dose (mSv)	0.23	0.04	0.00	0.08
	55 up	Number of Workers	126	350	0	476
		Average dose (mSv)	0.14	0.03	0.00	0.06
	Unknown	Number of Workers	0	1	0	1
		Average dose (mSv)	0.00	0.00	0.00	0.00
	Overall	**Number of Workers**	**753**	**3914**	**0**	**4667**
		Average dose (mSv)	**0.21**	**0.03**	**0.00**	**0.06**
Industry and Research	Below 25	Number of Workers	1329	787	0	2116
		Average dose (mSv)	1.81	0.10	0.00	1.17
	25-34	Number of Workers	3915	1978	0	5893
		Average dose (mSv)	0.98	0.12	0.00	0.69
	35-44	Number of Workers	4358	1466	0	5824
		Average dose (mSv)	0.78	0.33	0.00	0.67
	45-54	Number of Workers	3218	778	0	3996
		Average dose (mSv)	0.61	0.17	0.00	0.53
	55 up	Number of Workers	1328	187	0	1515
		Average dose (mSv)	0.38	0.16	0.00	0.35
	Unknown	Number of Workers	10	5	0	15
		Average dose (mSv)	0.27	0.08	0.00	0.21
	Overall	**Number of Workers**	**14158**	**5201**	**0**	**19359**
		Average dose (mSv)	**0.86**	**0.18**	**0.00**	**0.68**
Medicine	Below 25	Number of Workers	413	5071	0	5484
		Average dose (mSv)	0.16	0.04	0.00	0.05
	25-34	Number of Workers	3101	15727	0	18828
		Average dose (mSv)	0.13	0.07	0.00	0.08
	35-44	Number of Workers	4994	14239	0	19233
		Average dose (mSv)	0.14	0.09	0.00	0.10
	45-54	Number of Workers	4739	9406	0	14145
		Average dose (mSv)	0.09	0.09	0.00	0.09
	55 up	Number of Workers	3107	2397	0	5504
		Average dose (mSv)	0.07	0.06	0.00	0.07
	Unknown	Number of Workers	4	11	0	15
		Average dose (mSv)	0.00	0.01	0.00	0.01
	Overall	**Number of Workers**	**16358**	**46851**	**0**	**63209**
		Average dose (mSv)	**0.11**	**0.08**	**0.00**	**0.09**

Table 3 (Cont'd)
Dose distribution broken down by job sector, age and sex.

			Sex			
Job Sector	Age	Statistic	Male	Female	Unknown	Overall
Nuclear Power	Below 25	Number of Workers	957	219	0	1176
		Average dose (mSv)	0.63	0.15	0.00	0.54
		%tritium	16.25	29.43	0.00	16.93
	25-34	Number of Workers	2533	526	0	3059
		Average dose (mSv)	1.11	0.19	0.00	0.95
		%tritium	21.71	36.43	0.00	22.23
	35-44	Number of Workers	5889	907	0	6796
		Average dose (mSv)	1.21	0.27	0.00	1.09
		%tritium	19.02	24.16	0.00	19.19
	45-54	Number of Workers	6318	628	0	6946
		Average dose (mSv)	0.92	0.18	0.00	0.86
		%tritium	15.80	19.35	0.00	15.87
	55 up	Number of Workers	2772	95	0	2867
		Average dose (mSv)	0.48	0.12	0.00	0.47
		%tritium	16.57	28.82	0.00	16.68
	Overall	**Number of Workers**	**18469**	**2375**	**0**	**20844**
		Average dose (mSv)	**0.96**	**0.21**	**0.00**	**0.87**
		%tritium	**18.11**	**26.01**	**0.00**	**18.33**
Uranium Mining	Below 25	Number of Workers	99	24	0	123
		Average dose (mSv)	0.65	0.17	0.00	0.56
		% radon progeny	67.05	83.13	0.00	68.02
	25-34	Number of Workers	431	59	0	490
		Average dose (mSv)	1.21	0.33	0.00	1.11
		% radon progeny	43.79	52.94	0.00	44.12
	35-44	Number of Workers	558	58	0	616
		Average dose (mSv)	1.14	0.45	0.00	1.08
		% radon progeny	46.11	37.07	0.00	45.76
	45-54	Number of Workers	442	19	0	461
		Average dose (mSv)	0.88	0.29	0.00	0.85
		% radon progeny	44.65	61.47	0.00	44.88
	55 up	Number of Workers	166	7	0	173
		Average dose (mSv)	0.83	0.19	0.00	0.80
		% radon progeny	36.13	77.78	0.00	36.53
	Overall	**Number of Workers**	**1696**	**167**	**0**	**1863**
		Average dose (mSv)	**1.03**	**0.34**	**0.00**	**0.97**
		% radon progeny	**45.09**	**49.29**	**0.00**	**45.22**

2001 Final Analysis

Table 4
Dose Statistics by job category
Administrator

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	387	0.00	0.00
>0-1	190	66.83	0.35
>1-2	1	1.07	1.07
>2-5	1	4.50	4.50
>5-20	1	5.40	5.40
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	580	77.80	0.13
			Five year period 1997 - 2001
0	647	0.00	0.00
>0-5	332	351.35	1.06
>5-25	1	5.40	5.40
>25-100	1	29.10	29.10
>100	0	0.00	0.00
Total	981	385.85	0.39

Parameters of the distribution in 2001:

A: 0.9273
B: 0
C: 0
D: 2.1073
Sample size: 580

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

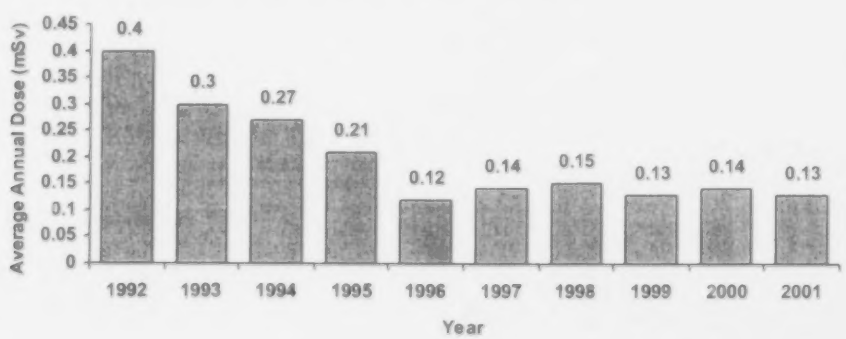


Table 4 (Cont'd)

Office staff

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	3448	0.00	0.00
>0-1	434	133.52	0.31
>1-2	15	19.56	1.30
>2-5	9	25.30	2.81
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	3906	178.38	0.05
			Five year period 1997 - 2001
0	5407	0.00	0.00
>0-5	1080	856.32	0.79
>5-25	17	130.87	7.70
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	6504	987.19	0.15

Parameters of the distribution in 2001 :

A: 0.6303
B: 0.0769
C: 0
D: 2.3672
Sample size: 3906

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

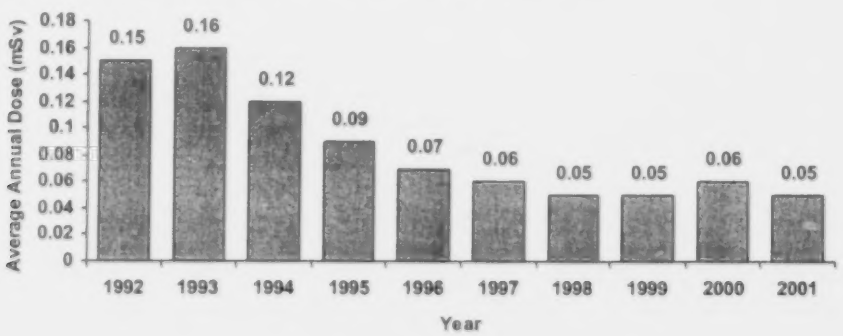


Table 4 (Cont'd)

Safety officer

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	135	0.00	0.00
>0-1	48	12.31	0.26
>1-2	6	6.84	1.14
>2-5	1	4.30	4.30
>5-20	1	5.80	5.80
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	191	29.25	0.15
			Five year period 1997 - 2001
0	161	0.00	0.00
>0-5	87	66.37	0.76
>5-25	6	62.52	10.42
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	254	128.89	0.51

Parameters of the distribution in 2001 :

A: 0.5560
B: 0.0168
C: 0.0042
D: 1.8305
Sample size: 191

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

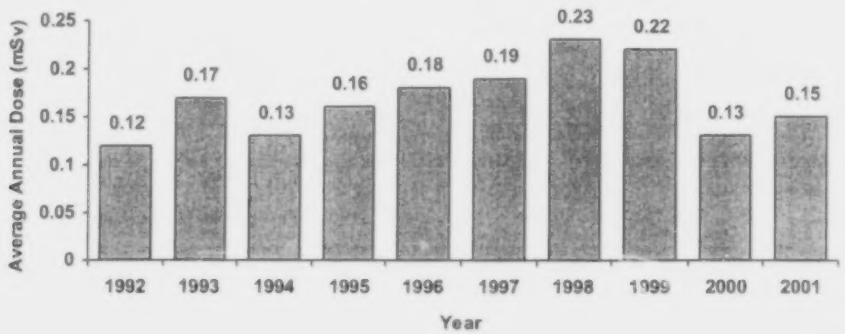


Table 4 (Cont'd)

Industrial radiographer

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	1209	0.00	0.00
>0-1	485	194.82	0.40
>1-2	212	322.41	1.52
>2-5	398	1373.20	3.45
>5-20	523	5190.40	9.92
>20-50	55	1437.04	26.13
>50	1	119.82	119.82
Total	2883	8637.69	3.00
			Five year period 1997 - 2001
0	1730	0.00	0.00
>0-5	1211	1881.74	1.55
>5-25	912	11925.75	13.08
>25-100	499	22475.09	45.04
>100	22	3390.49	154.11
Total	4374	39673.07	9.07

Parameters of the distribution in 2001 :

A: 0.1767
B: 0.0633
C: 0
D: 0.2025
Sample size: 2883

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

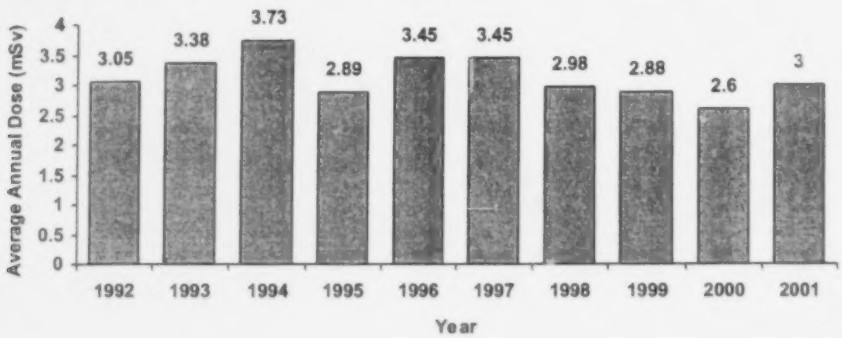


Table 4 (Cont'd)

Instructor (non-medical)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	176	0.00	0.00
>0-1	11	2.97	0.27
>1-2	0	0.00	0.00
>2-5	1	2.77	2.77
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	188	5.74	0.03
			Five year period 1997 - 2001
0	266	0.00	0.00
>0-5	54	26.64	0.49
>5-25	0	0.00	0.00
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	320	26.64	0.08

Parameters of the distribution in 2001 :

A: 0.3209
B: 0.0850
C: 0.0419
D: 2.4447
Sample size: 188

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

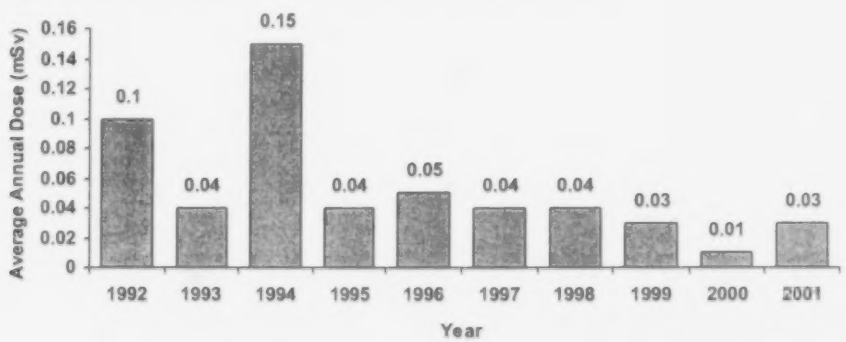


Table 4 (Cont'd)

Instrument technician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	1794	0.00	0.00
>0-1	429	140.37	0.33
>1-2	33	42.62	1.29
>2-5	21	64.28	3.06
>5-20	11	81.36	7.40
>20-50	5	201.54	40.31
>50	7	481.04	68.72
Total	2300	1011.21	0.44
			Five year period 1997 - 2001
0	2468	0.00	0.00
>0-5	1048	880.13	0.84
>5-25	79	798.44	10.11
>25-100	15	693.93	46.26
>100	1	122.23	122.23
Total	3611	2494.73	0.69

Parameters of the distribution in 2001:

A: 0.2450
B: 0.0025
C: 0.1173
D: 1.9075
Sample size: 2300

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

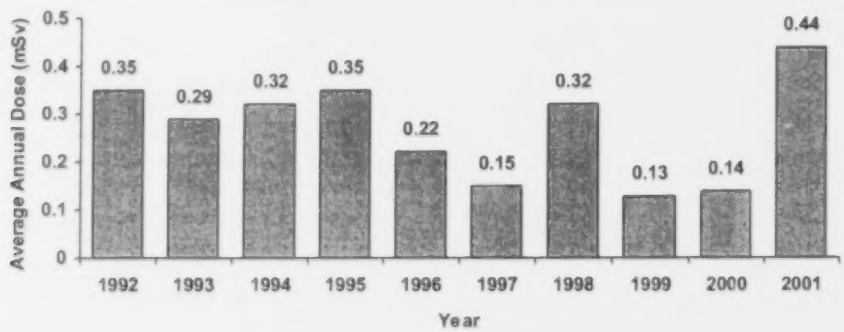


Table 4 (Cont'd)

Laboratory technician (industrial)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	3507	0.00	0.00
>0-1	712	229.78	0.32
>1-2	85	127.22	1.50
>2-5	73	227.24	3.11
>5-20	12	104.94	8.74
>20-50	2	87.34	43.67
>50	1	151.38	151.38
Total	4392	927.90	0.21
			Five year period 1997 - 2001
0	5298	0.00	0.00
>0-5	2138	1598.70	0.75
>5-25	153	1497.62	9.79
>25-100	8	265.59	33.20
>100	1	151.38	151.38
Total	7598	3513.29	0.46

Parameters of the distribution in 2001 :

A: 0.4254
B: 0.00004
C: 0.0255
D: 1.8135
Sample size: 4392

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

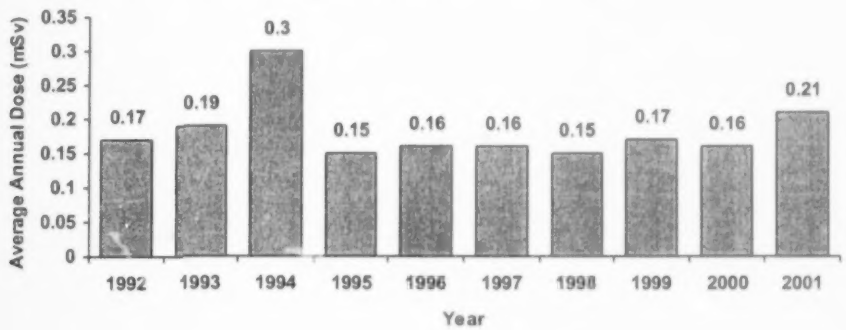


Table 4 (Cont'd)

Nuclear fuel processor

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	121	0.00	0.00
>0-1	265	120.73	0.46
>1-2	93	140.10	1.51
>2-5	91	293.64	3.23
>5-20	33	250.38	7.59
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	603	804.85	1.33
			Five year period 1997 - 2001
0	65	0.00	0.00
>0-5	412	667.61	1.62
>5-25	168	1760.68	10.48
>25-100	20	648.30	32.42
>100	0	0.00	0.00
Total	665	3076.59	4.63

Parameters of the distribution in 2001 :

A: 0.5331
B: 0.0948
C: 0.0099
D: 0.2454
Sample size: 603

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

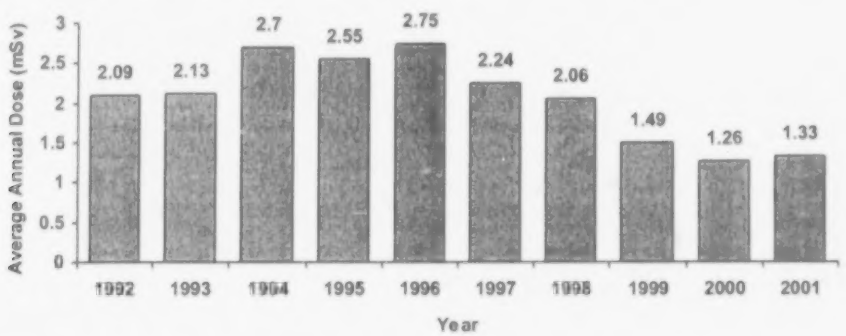


Table 4 (Cont'd)

Scientist/Engineer (field)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	706	0.00	0.00
>0-1	502	177.48	0.35
>1-2	33	44.60	1.35
>2-5	18	53.61	2.98
>5-20	7	47.41	6.77
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1266	323.10	0.26
			Five year period 1997 - 2001
0	1123	0.00	0.00
>0-5	1227	1346.07	1.10
>5-25	53	474.20	8.95
>25-100	7	236.45	33.78
>100	0	0.00	0.00
Total	2410	2056.72	0.85

Parameters of the distribution in 2001:

A: 0.7228
B: 0
C: 0.0245
D: 1.6477
Sample size: 1266

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

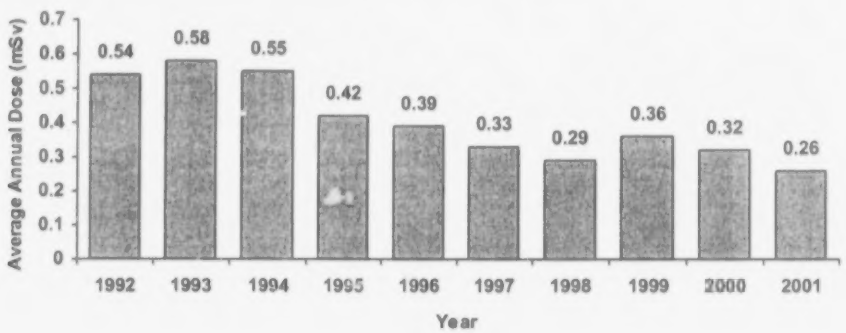


Table 4 (Cont'd)

Scientist/Engineer (laboratory)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	5249	0.00	0.00
>0-1	1087	287.74	0.26
>1-2	19	24.97	1.31
>2-5	9	26.24	2.92
>5-20	2	24.09	12.04
>20-50	1	43.48	43.48
>50	5	404.94	80.99
Total	6372	811.46	0.13
			Five year period 1997 - 2001
0	7709	0.00	0.00
>0-5	2532	1166.42	0.46
>5-25	18	178.30	9.91
>25-100	5	298.74	59.75
>100	1	149.88	149.88
Total	10265	1793.34	0.17

Parameters of the distribution in 2001 :

A: 0.2678
B: 0.0003
C: 0.1871
D: 2.5566
Sample size: 6372

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

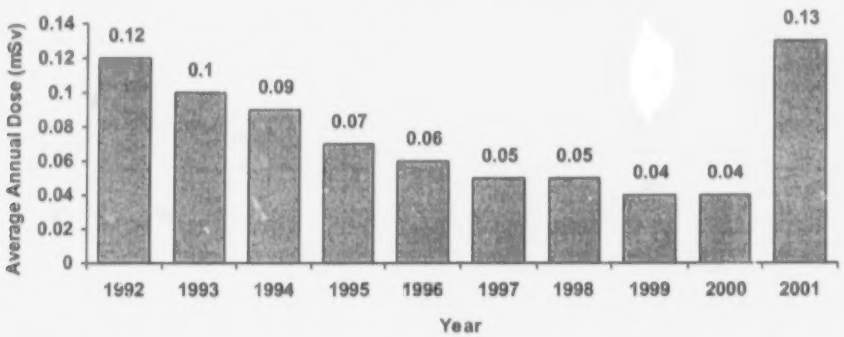


Table 4 (Cont'd)

Tradesmen

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	76	0.00	0.00
>0-1	23	7.21	0.31
>1-2	3	3.62	1.21
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	102	10.83	0.11
			Five year period 1997 - 2001
0	79	0.00	0.00
>0-5	37	25.13	0.68
>5-25	0	0.00	0.00
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	116	25.13	0.22

Parameters of the distribution in 2001 :

A: 0
B: 0.8988
C: 0.0856
D: 1.1907
Sample size: 102

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

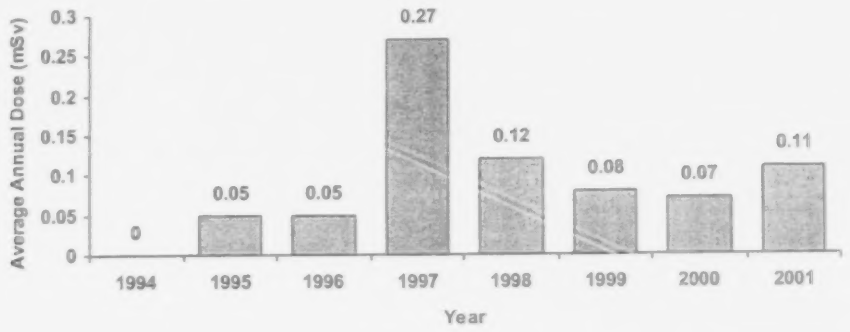


Table 4 (Cont'd)

Well logger

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	723	0.00	0.00
>0-1	451	186.85	0.41
>1-2	102	149.08	1.46
>2-5	45	136.13	3.03
>5-20	10	70.26	7.03
>20-50	1	25.47	25.47
>50	0	0.00	0.00
Total	1332	567.79	0.43
			Five year period 1997 - 2001
0	980	0.00	0.00
>0-5	1116	1256.44	1.13
>5-25	122	1178.85	9.66
>25-100	5	193.60	38.72
>100	0	0.00	0.00
Total	2223	2628.89	1.18

Parameters of the distribution in 2001:

A: 0.5682
B: 0.0488
C: 0
D: 1.1409
Sample size: 1332

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

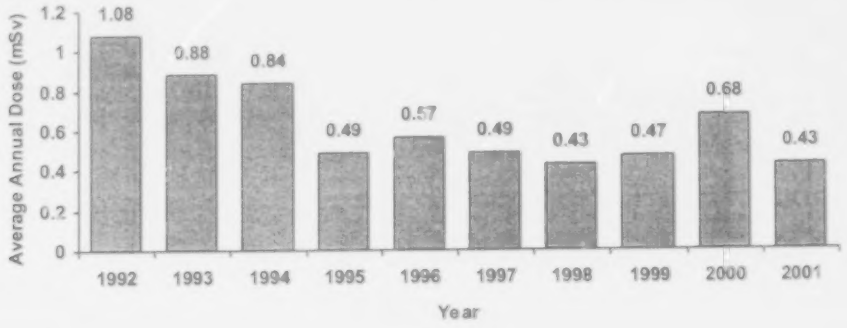


Table 4 (Cont'd)

Chiropractor

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	984	0.00	0.00
>0-1	46	13.76	0.30
>1-2	9	13.11	1.46
>2-5	3	8.84	2.95
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1042	35.71	0.03
			Five year period 1997 - 2001
0	1229	0.00	0.00
>0-5	164	106.79	0.65
>5-25	3	20.32	6.77
>25-100	1	32.44	32.44
>100	0	0.00	0.00
Total	1397	159.55	0.11

Parameters of the distribution in 2001:

A: 0
B: 0.3361
C: 0.0736
D: 2.0586
Sample size: 1042

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

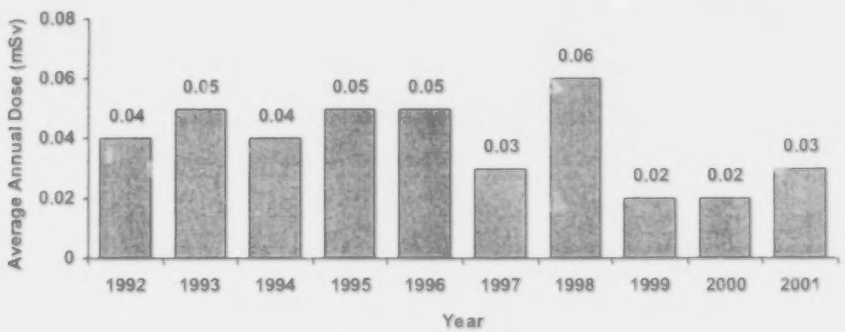


Table 4 (Cont'd)

Dental assistant

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	11236	0.00	0.00
>0-1	221	63.53	0.29
>1-2	2	2.40	1.20
>2-5	1	2.40	2.40
>5-20	1	6.00	6.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	11461	74.33	0.01
			Five year period 1997 - 2001
0	16249	0.00	0.00
>0-5	804	298.45	0.37
>5-25	8	72.30	9.04
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	17061	370.75	0.02

Parameters of the distribution in 2001:

A: 0.6365
B: 0
C: 0.0356
D: 3.3428
Sample size: 11461

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

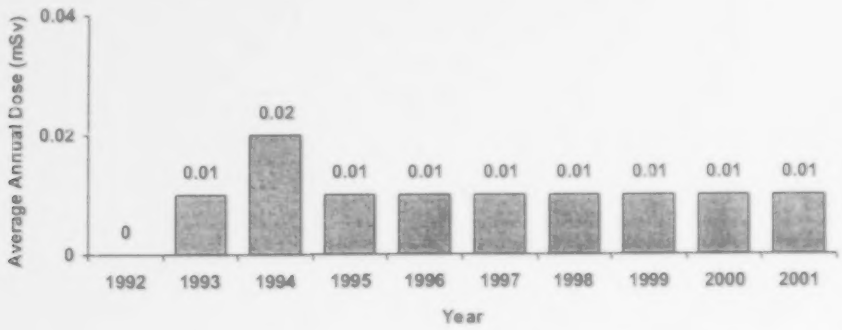


Table 4 (Cont'd)

Dental hygienist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	8013	0.00	0.00
>0-1	149	45.68	0.31
>1-2	1	1.10	1.10
>2-5	1	2.20	2.20
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	1	102.50	102.50
Total	8165	151.48	0.02
			Five year period 1997 - 2001
0	10249	0.00	0.00
>0-5	622	249.78	0.40
>5-25	5	49.20	9.84
>25-100	0	0.00	0.00
>100	1	102.50	102.50
Total	10877	401.48	0.04

Parameters of the distribution in 2001 :

A: 0.2564
B: 0
C: 0.1535
D: 3.2912
Sample size: 8165

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

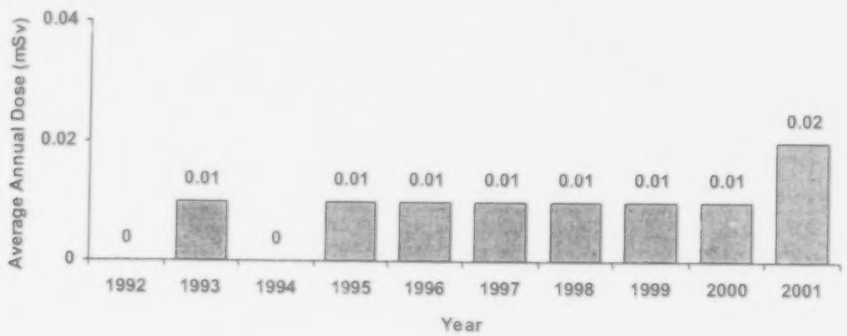


Table 4 (Cont'd)

Dental therapist/nurse

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	112	0.00	0.00
>0-1	3	0.90	0.30
>1-2	0	0.00	0.00
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	115	0.90	0.01
			Five year period 1997 - 2001
0	151	0.00	0.00
>0-5	15	6.70	0.45
>5-25	0	0.00	0.00
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	166	6.70	0.04

Parameters of the distribution in 2001:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

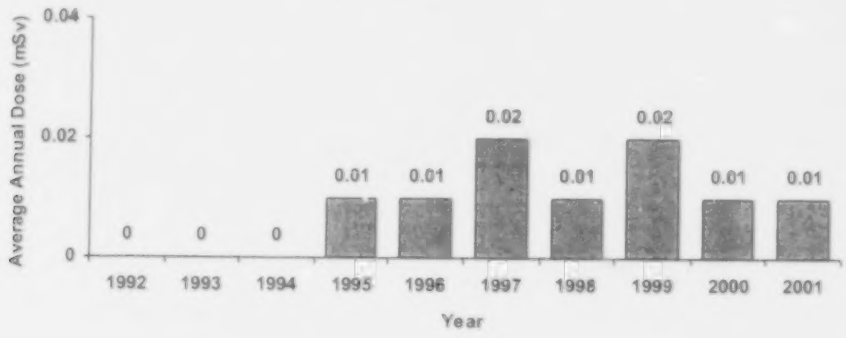


Table 4 (Cont'd)

Dentist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	7140	0.00	0.00
>0-1	174	51.86	0.30
>1-2	4	4.80	1.20
>2-5	3	8.90	2.97
>5-20	1	5.90	5.90
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	7322	71.46	0.01
			Five year period 1997 - 2001
0	8325	0.00	0.00
>0-5	735	306.16	0.42
>5-25	3	40.50	13.50
>25-100	1	26.34	26.34
>100	0	0.00	0.00
Total	9064	373.00	0.04

Parameters of the distribution in 2001:

A: 0.4524
B: 0.0003
C: 0.0660
D: 3.1001
Sample size: 7322

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

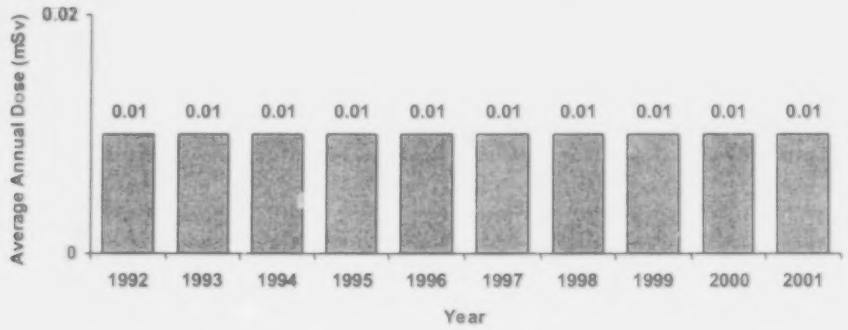


Table 4 (Cont'd)

Gynaecologist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	13	0.00	0.00
>0-1	1	0.20	0.20
>1-2	0	0.00	0.00
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	14	0.20	0.01
			Five year period 1997 - 2001
0	25	0.00	0.00
>0-5	9	7.30	0.81
>5-25	0	0.00	0.00
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	34	7.30	0.21

Parameters of the distribution in 2001:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

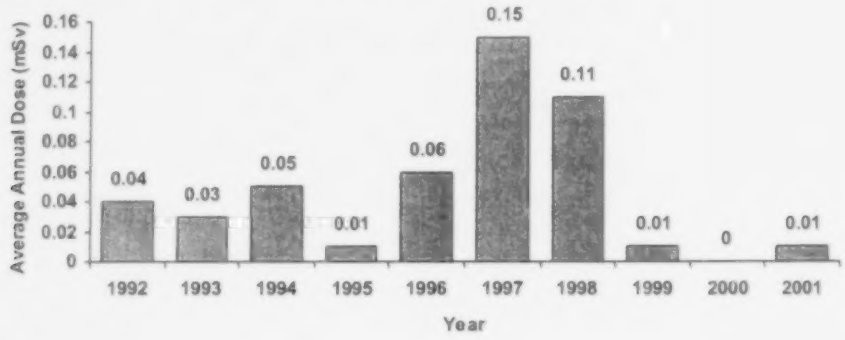


Table 4 (Cont'd)

Laboratory technician (medical)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	2795	0.00	0.00
>0-1	340	98.84	0.29
>1-2	25	37.67	1.51
>2-5	25	74.65	2.99
>5-20	3	15.80	5.27
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	3188	226.96	0.07
			Five year period 1997 - 2001
0	4766	0.00	0.00
>0-5	1170	655.13	0.56
>5-25	31	273.46	8.82
>25-100	2	66.60	33.30
>100	1	197.30	197.30
Total	5970	1192.49	0.20

Parameters of the distribution in 2001 :

A: 0
B: 0.2354
C: 0.1402
D: 2.0036
Sample size: 3188

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

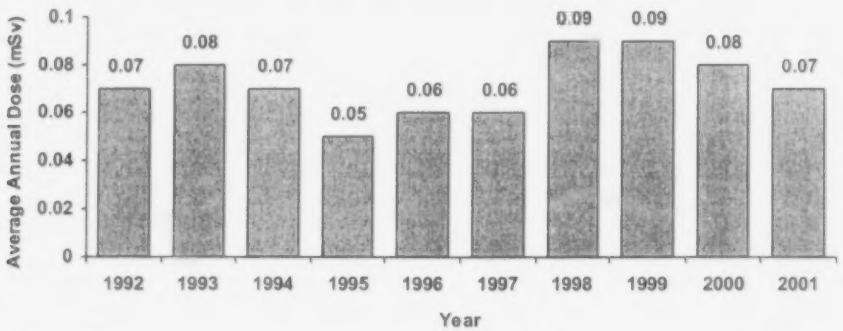


Table 4 (Cont'd)

Medical physicist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	294	0.00	0.00
>0-1	38	10.06	0.26
>1-2	3	5.22	1.74
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	1	50.70	50.70
Total	336	65.98	0.20
			Five year period 1997 - 2001
0	325	0.00	0.00
>0-5	134	73.88	0.55
>5-25	3	24.50	8.17
>25-100	2	92.10	46.05
>100	0	0.00	0.00
Total	464	190.48	0.41

Parameters of the distribution in 2001 :

A: 0.1566
B: 0.0039
C: 0.1499
D: 2.3675
Sample size: 336

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

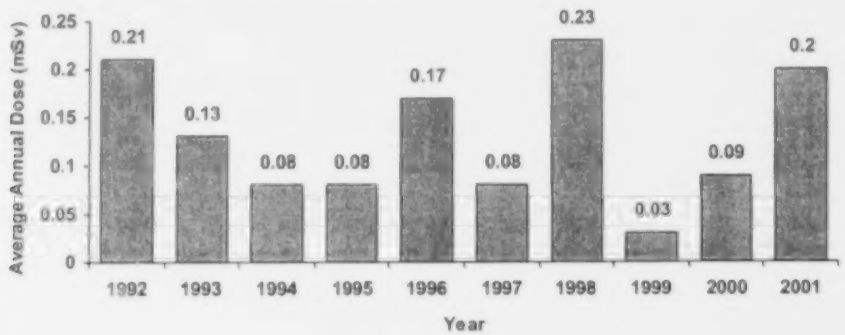


Table 4 (Cont'd)

Medical radiation technologist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	10391	0.00	0.00
>0-1	1718	512.86	0.30
>1-2	101	145.76	1.44
>2-5	64	200.56	3.13
>5-20	13	110.66	8.51
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	12287	969.84	0.08
			Five year period 1997 - 2001
0	10079	0.00	0.00
>0-5	5390	3491.68	0.65
>5-25	111	1042.55	9.39
>25-100	3	116.30	38.77
>100	0	0.00	0.00
Total	15583	4650.53	0.30

Parameters of the distribution in 2001 :

A: 0.3520
B: 0.0459
C: 0.0891
D: 2.2125
Sample size: 12287

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

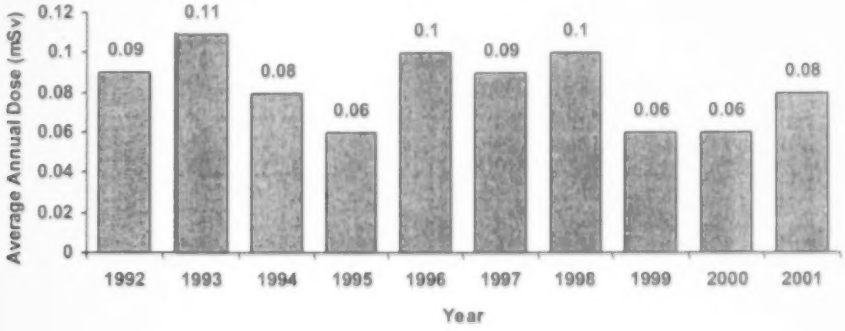


Table 4 (Cont'd)

Nuclear medicine technologist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	411	0.00	0.00
>0-1	371	200.84	0.54
>1-2	319	483.97	1.52
>2-5	391	1198.76	3.07
>5-20	50	347.56	6.95
>20-50	1	23.14	23.14
>50	0	0.00	0.00
Total	1543	2254.27	1.46
			Five year period 1997 - 2001
0	516	0.00	0.00
>0-5	878	1693.43	1.93
>5-25	708	7576.86	10.70
>25-100	23	752.28	32.71
>100	0	0.00	0.00
Total	2125	10022.57	4.72

Parameters of the distribution in 2001 :

A: 0.2457
B: 0.2949
C: 0.0000
D: -0.2204
Sample size: 1543

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

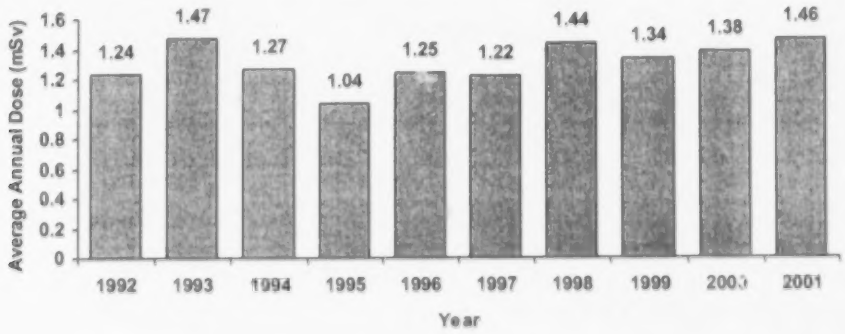


Table 4 (Cont'd)

Nurse

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	4389	0.00	0.00
>0-1	886	324.08	0.37
>1-2	58	80.77	1.39
>2-5	16	44.51	2.78
>5-20	1	5.84	5.84
>20-50	1	26.60	26.60
>50	0	0.00	0.00
Total	5351	481.80	0.09
			Five year period 1997 - 2001
0	5798	0.00	0.00
>0-5	2688	2415.04	0.90
>5-25	31	243.01	7.84
>25-100	2	58.30	29.15
>100	0	0.00	0.00
Total	8519	2716.35	0.32

Parameters of the distribution in 2001 :

A: 0.6288
B: 0.0131
C: 0
D: 2.0715
Sample size: 5351

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

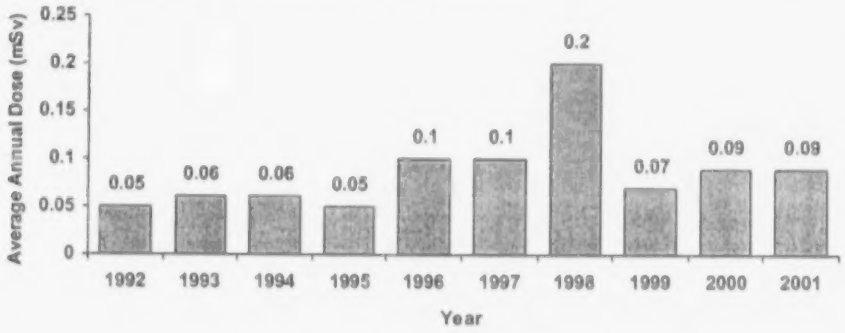


Table 4 (Cont'd)

Physician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	1642	0.00	0.00
>0-1	442	147.06	0.33
>1-2	60	83.51	1.39
>2-5	25	72.96	2.92
>5-20	6	51.90	8.65
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	2175	355.43	0.16
			Five year period 1997 - 2001
0	1894	0.00	0.00
>0-5	1197	1087.11	0.91
>5-25	63	559.91	8.89
>25-100	4	169.70	42.42
>100	0	0.00	0.00
Total	3158	1816.72	0.58

Parameters of the distribution in 2001 :

A: 0.4444
B: 0.0577
C: 0.0276
D: 1.7248
Sample size: 2175

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

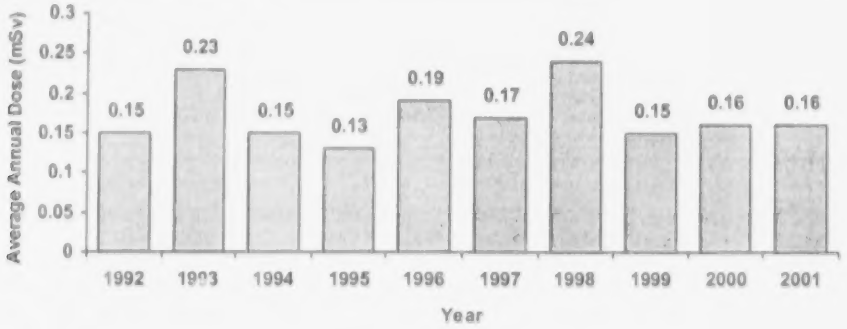


Table 4 (Cont'd)

Radiation therapist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	1217	0.00	0.00
>0-1	283	76.72	0.27
>1-2	10	14.70	1.47
>2-5	6	17.73	2.96
>5-20	4	48.94	12.24
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1520	158.09	0.10
			Five year period 1997 - 2001
0	1016	0.00	0.00
>0-5	791	486.11	0.61
>5-25	21	219.78	10.47
>25-100	2	100.30	50.15
>100	0	0.00	0.00
Total	1830	806.19	0.44

Parameters of the distribution in 2001:

A: 0.2680
B: 0.0176
C: 0.1533
D: 2.3031
Sample size: 1520

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

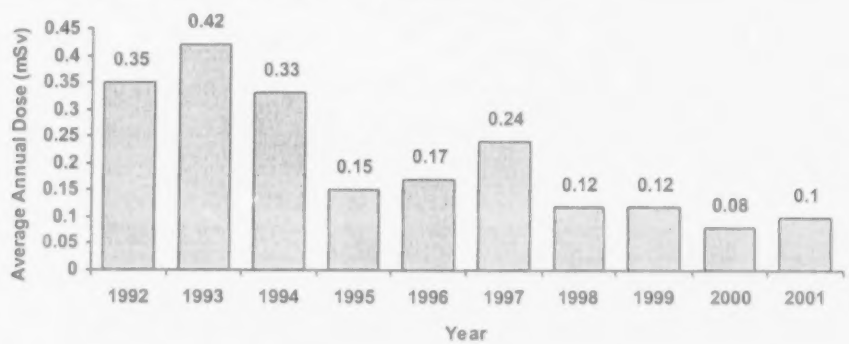


Table 4 (Cont'd)

Radiologist (diagnostic)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	1555	0.00	0.00
>0-1	314	107.04	0.34
>1-2	25	35.34	1.41
>2-5	17	53.73	3.16
>5-20	9	78.78	8.75
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1920	274.89	0.14
			Five year period 1997 - 2001
0	1450	0.00	0.00
>0-5	991	829.03	0.84
>5-25	40	411.53	10.29
>25-100	4	133.60	33.40
>100	0	0.00	0.00
Total	2485	1374.16	0.55

Parameters of the distribution in 2001:

A: 0.3039
B: 0.0419
C: 0.0899
D: 1.9402
Sample size: 1920

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

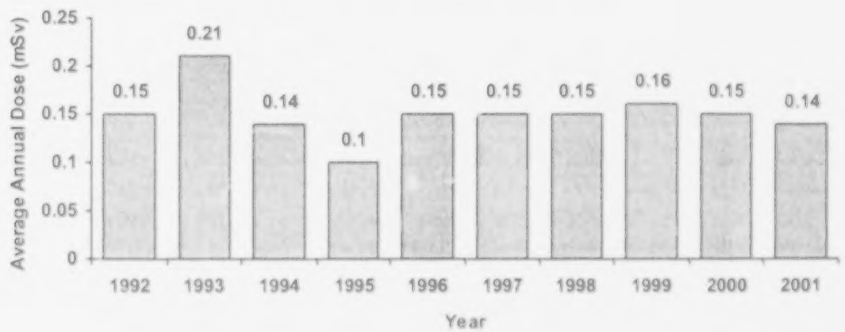


Table 4 (Cont'd)

Radiologist (therapeutic)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	192	0.00	0.00
>0-1	37	12.48	0.34
>1-2	2	2.85	1.42
>2-5	3	9.21	3.07
>5-20	1	7.30	7.30
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	235	31.84	0.14
			Five year period 1997 - 2001
0	198	0.00	0.00
>0-5	104	62.84	0.60
>5-25	2	16.80	8.40
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	304	79.64	0.26

Parameters of the distribution in 2001 :

A: 0.1306
B: 0.1246
C: 0.1117
D: 1.8411
Sample size: 235

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

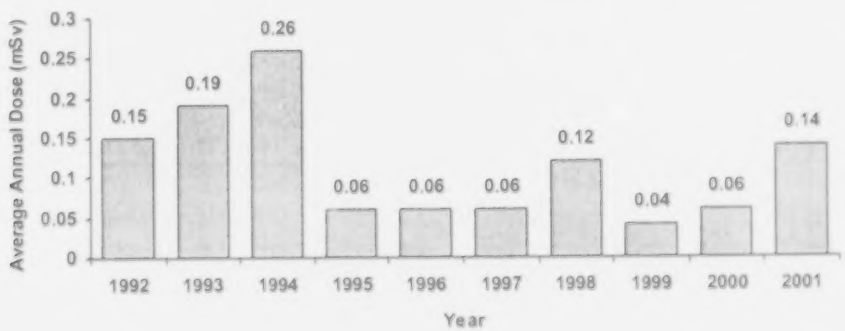


Table 4 (Cont'd)

Veterinarian

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	3510	0.00	0.00
>0-1	323	88.17	0.27
>1-2	10	11.69	1.17
>2-5	6	19.18	3.20
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	3849	119.04	0.03
			Five year period 1997 - 2001
0	4796	0.00	0.00
>0-5	1010	501.22	0.50
>5-25	10	77.55	7.76
>25-100	2	60.90	30.45
>100	0	0.00	0.00
Total	5818	639.67	0.11

Parameters of the distribution in 2001 :

A: 0.4261
B: 0.0861
C: 0.0672
D: 2.5943
Sample size: 3849

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

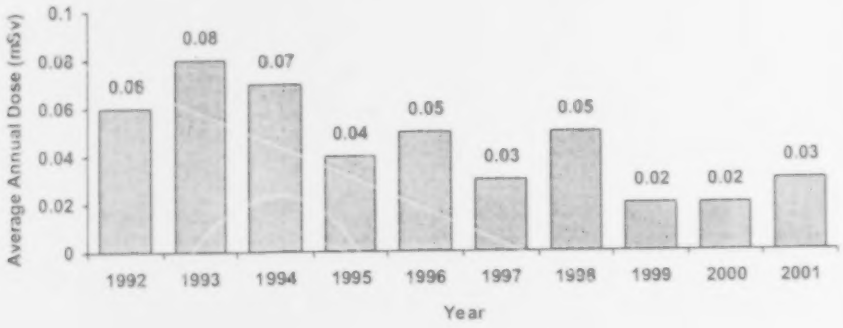


Table 4 (Cont'd)

Veterinary technician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	1829	0.00	0.00
>0-1	155	42.97	0.28
>1-2	6	9.43	1.57
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1990	52.40	0.03
			Five year period 1997 - 2001
0	2244	0.00	0.00
>0-5	251	125.70	0.50
>5-25	1	13.20	13.20
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	2496	138.90	0.06

Parameters of the distribution in 2001:

A: 0.5491
B: 0.2275
C: 0
D: 2.4957
Sample size: 1990

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

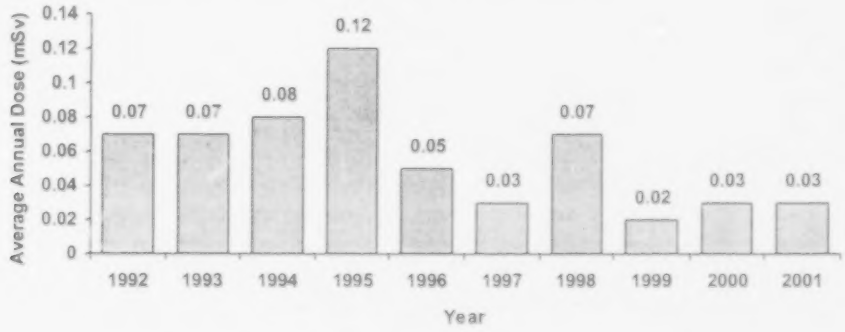


Table 4 (Cont'd)

Ward aid/orderly

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2001
0	1234	0.00	0.00
>0-1	116	40.19	0.35
>1-2	8	12.97	1.62
>2-5	5	14.63	2.93
>5-20	1	5.11	5.11
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1364	72.90	0.05
			Five year period 1997 - 2001
0	2157	0.00	0.00
>0-5	482	307.34	0.64
>5-25	13	125.96	9.69
>25-100	2	123.60	61.80
>100	0	0.00	0.00
Total	2654	556.90	0.21

Parameters of the distribution in 2001:

A: 0.4974
B: 0.0604
C: 0.0000
D: 2.2021
Sample size: 1364

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

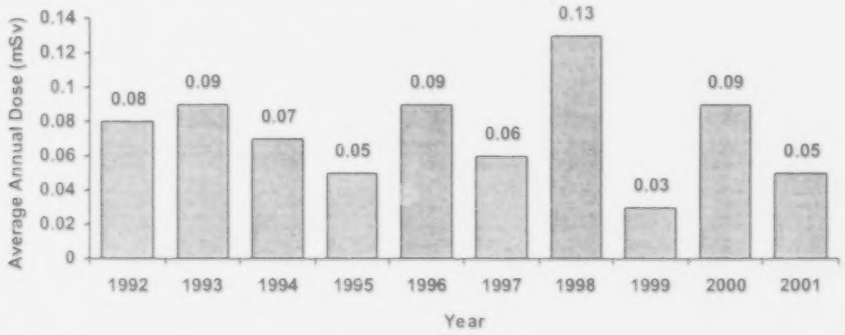


Table 4 (Cont'd)

Reactor - administration

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	3862	0.00	0.00	0
>0-1	562	146.04	0.26	44
>1-2	105	147.98	1.41	46
>2-5	98	307.55	3.14	36
>5-20	39	307.02	7.87	25
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	4666	908.59	0.19	35
				Five year period 1997 - 2001
0	5249	0.00	0.00	0
>0-5	2040	1874.45	0.92	36
>5-25	300	2964.27	9.88	34
>25-100	8	241.53	30.19	24
>100	0	0.00	0.00	0
Total	7597	5080.25	0.67	34

Parameters of the distribution in 2001:

A: 0.1886
B: 0.1060
C: 0
D: 1.5306
Sample size: 4666

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

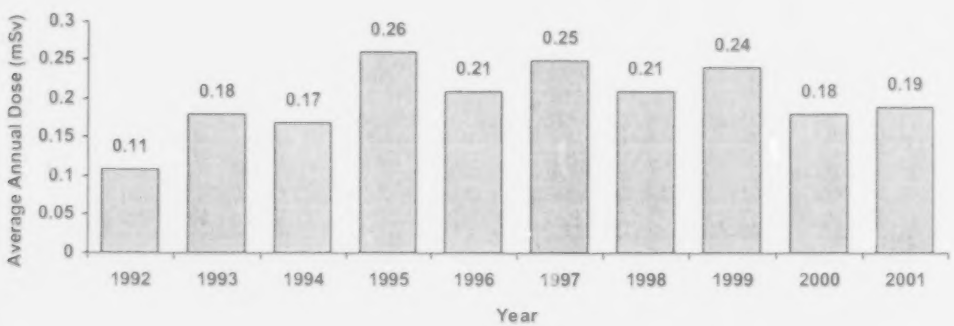


Table 4 (Cont'd)

Reactor - chemical and radiation control

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	130	0.00	0.00	0
>0-1	151	52.74	0.35	43
>1-2	52	72.14	1.39	37
>2-5	51	1 [illegible]54	3.09	17
>5-20	38	333.75	8.78	11
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	422	616.17	1.46	19
				Five year period 1997 - 2001
0	123	0.00	0.00	0
>0-5	302	411.69	1.36	41
>5-25	115	1207.26	10.50	18
>25-100	30	1275.69	42.52	11
>100	0	0.00	0.00	0
Total	570	2894.64	5.08	18

Parameters of the distribution in 2001:

A: 0.3207
B: 0.0880
C: 0
D: 0.3763
Sample size: 422

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

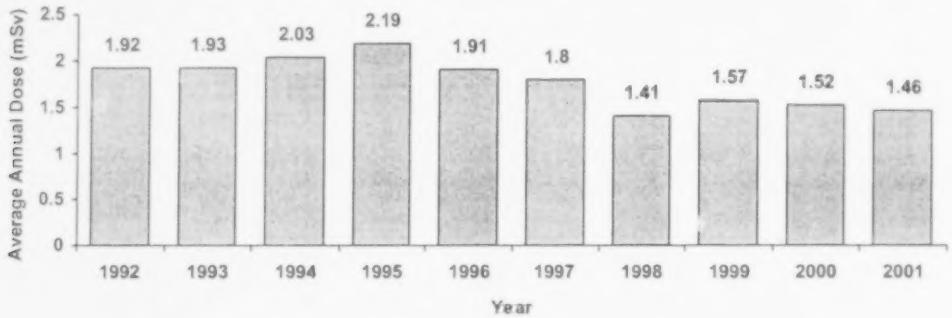


Table 4 (Cont'd)

Reactor - construction

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	979	0.00	0.00	0
>0-1	397	149.47	0.38	26
>1-2	181	261.43	1.44	20
>2-5	284	930.20	3.28	17
>5-20	234	2039.69	8.72	12
>20-50	2	44.61	22.30	1
>50	0	0.00	0.00	0
Total	2077	3425.40	1.65	14
				Five year period 1997 - 2001
0	1488	0.00	0.00	0
>0-5	1233	1882.30	1.53	17
>5-25	594	6840.19	11.52	12
>25-100	123	4443.19	36.12	11
>100	0	0.00	0.00	0
Total	3438	13165.68	3.83	12

Parameters of the distribution in 2001:

A: 0.1369
B: 0.1240
C: 0.1182
D: 0.3173
Sample size: 2077

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

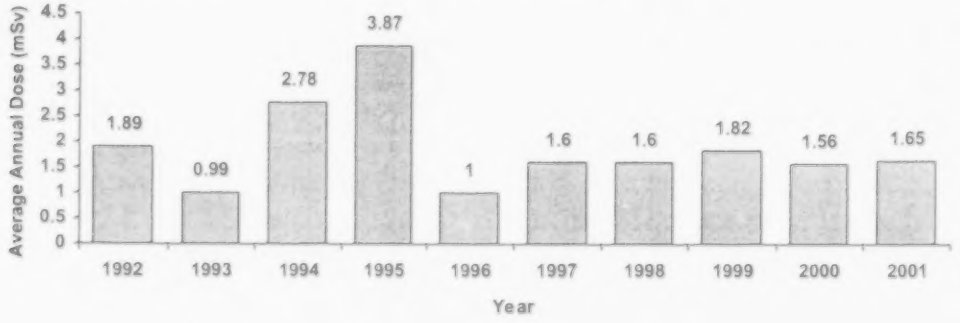


Table 4 (Cont'd)

Reactor - control technician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	68	0.00	0.00	0
>0-1	64	23.32	0.36	25
>1-2	20	29.58	1.48	16
>2-5	17	50.75	2.99	12
>5-20	6	42.08	7.01	6
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	175	145.73	0.83	13
				Five year period 1997 - 2001
0	107	0.00	0.00	0
>0-5	108	148.52	1.38	19
>5-25	47	526.10	11.19	16
>25-100	3	90.99	30.33	2
>100	0	0.00	0.00	0
Total	265	765.61	2.89	15

Parameters of the distribution in 2001:

A: 0.2473
B: 0.1979
C: 0
D: 0.4719
Sample size: 175

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

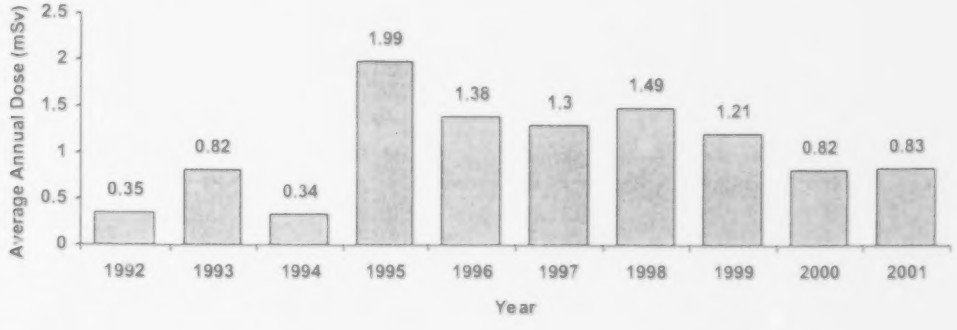


Table 4 (Cont'd)

Reactor - electrical maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	608	0.00	0.00	0
>0-1	395	121.32	0.31	36
>1-2	120	174.54	1.45	29
>2-5	137	440.64	3.22	19
>5-20	71	577.61	8.14	10
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	1331	1314.11	0.99	18
				Five year period 1997 - 2001
0	522	0.00	0.00	0
>0-5	910	1148.17	1.26	26
>5-25	309	3349.83	10.84	16
>25-100	24	755.17	31.47	13
>100	0	0.00	0.00	0
Total	1765	5253.17	2.98	18

Parameters of the distribution in 2001:

A: 0.2278
B: 0.1234
C: 0
D: 0.5861
Sample size: 1331

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

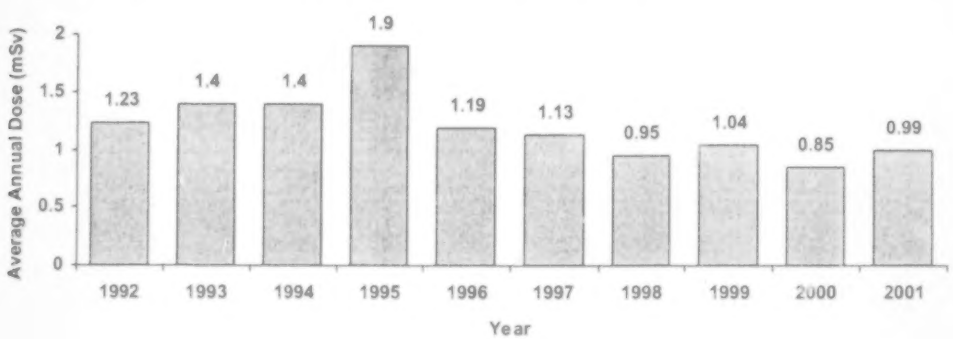


Table 4 (Cont'd)

Reactor - fuel handling

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	7	0.00	0.00	0
>0-1	8	2.55	0.32	20
>1-2	10	14.89	1.49	42
>2-5	9	29.21	3.25	23
>5-20	13	102.26	7.87	25
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	47	148.91	3.17	26
				Five year period 1997 - 2001
0	9	0.00	0.00	0
>0-5	19	36.10	1.90	7
>5-25	36	414.70	11.52	16
>25-100	18	721.37	40.08	22
>100	0	0.00	0.00	0
Total	82	1172.17	14.29	19

Parameters of the distribution in 2001:

A: 0.1181
B: 0.2039
C: 0.1088
D: -0.5668
Sample size: 47

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

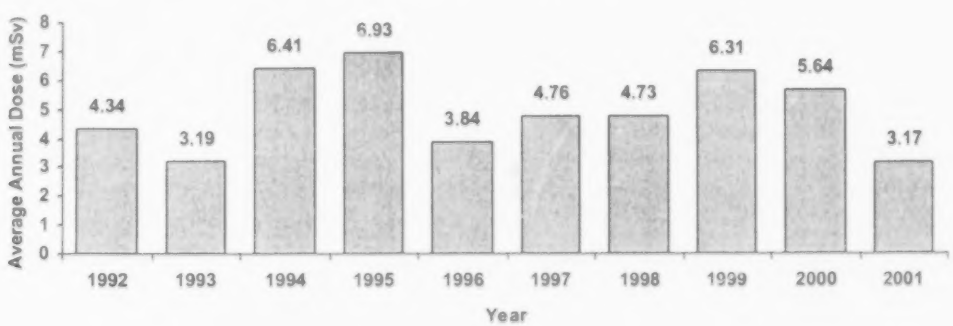


Table 4 (Cont'd)

Reactor - general maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	917	0.00	0.00	0
>0-1	299	102.41	0.34	28
>1-2	76	109.79	1.44	24
>2-5	99	324.46	3.28	22
>5-20	106	902.35	8.51	13
>20-50	5	113.54	22.71	1
>50	0	0.00	0.00	0
Total	1502	1552.55	1.03	16
				Five year period 1997 - 2001
0	1468	0.00	0.00	0
>0-5	816	1030.19	1.26	23
>5-25	288	3246.04	11.27	15
>25-100	52	1825.77	35.11	12
>100	0	0.00	0.00	0
Total	2624	6102.00	2.33	15

Parameters of the distribution in 2001:

A: 0.1753
B: 0.0807
C: 0
D: 0.7804
Sample size: 1502

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

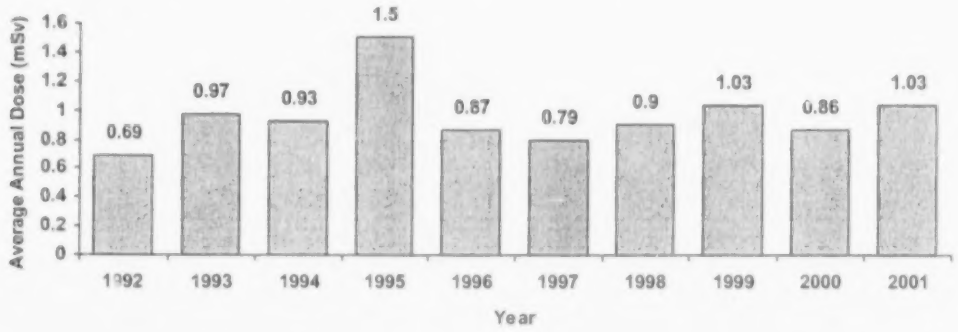


Table 4 (Cont'd)

Reactor - health physics

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	37	0.00	0.00	0
>0-1	18	6.10	0.34	9
>1-2	2	2.88	1.44	14
>2-5	5	15.52	3.10	15
>5-20	1	5.17	5.17	27
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	63	29.67	0.47	16
				Five year period 1997 - 2001
0	91	0.00	0.00	0
>0-5	47	59.84	1.27	20
>5-25	9	95.87	10.65	14
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	147	155.71	1.06	16

Parameters of the distribution in 2001:

A: 0.2252
B: 0.2049
C: 0
D: 0.8469
Sample size: 63

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

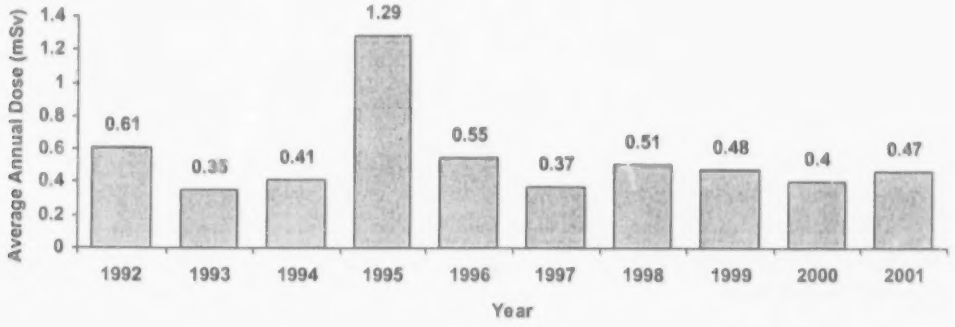


Table 4 (Cont'd)

Reactor - industrial radiographer

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	7	0.00	0.00	0
>0-1	19	7.99	0.42	5
>1-2	7	11.35	1.62	8
>2-5	9	31.38	3.49	10
>5-20	3	19.01	6.34	6
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	45	69.73	1.55	8
				Five year period 1997 - 2001
0	10	0.00	0.00	0
>0-5	34	63.03	1.85	10
>5-25	24	209.31	8.72	9
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	68	272.34	4.01	9

Parameters of the distribution in 2001:

A: 0.3005
B: 0.2274
C: 0.0142
D: -0.1041
Sample size: 45

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

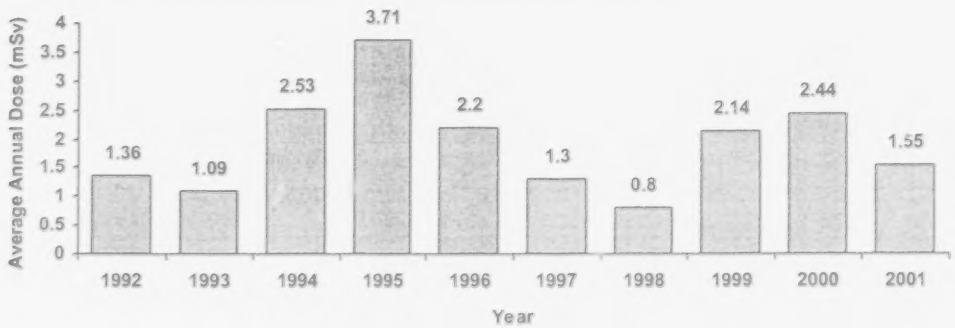


Table 4 (Cont'd)

Reactor - mechanical maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	451	0.00	0.00	0
>0-1	465	174.78	0.38	37
>1-2	157	235.48	1.50	23
>2-5	253	816.22	3.23	16
>5-20	230	2109.27	9.17	9
>20-50	2	41.47	20.74	4
>50	0	0.00	0.00	0
Total	1558	3377.22	2.17	13
				Five year period 1997 - 2001
0	712	0.00	0.00	0
>0-5	1116	1589.50	1.42	23
>5-25	656	8103.78	12.35	14
>25-100	161	5603.99	34.81	13
>100	0	0.00	0.00	0
Total	2645	15297.27	5.78	14

Parameters of the distribution in 2001:

A: 0.2400
B: 0.1011
C: 0.0000
D: 0.1162
Sample size: 1558

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

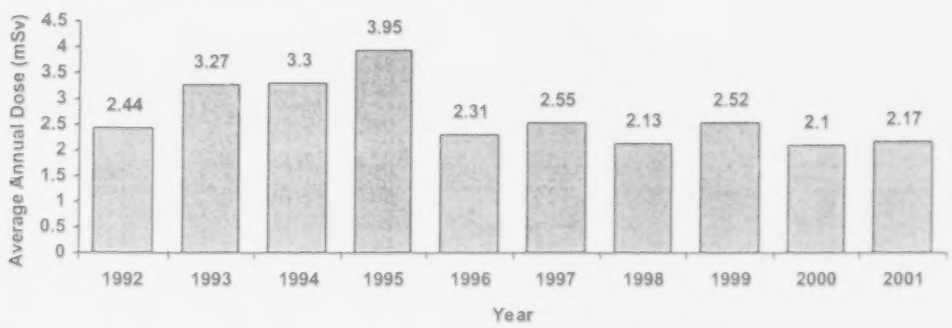


Table 4 (Cont'd)

Reactor - operations

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	787	0.00	0.00	0
>0-1	774	265.41	0.34	49
>1-2	253	367.42	1.45	48
>2-5	233	715.97	3.07	44
>5-20	122	1097.26	8.99	17
>20-50	1	22.37	22.37	7
>50	0	0.00	0.00	0
Total	2170	2468.43	1.14	33
				Five year period 1997 - 2001
0	508	0.00	0.00	0
>0-5	1334	2033.24	1.52	47
>5-25	589	5877.41	9.98	37
>25-100	101	4380.95	43.38	14
>100	0	0.00	0.00	0
Total	2532	12291.60	4.85	30

Parameters of the distribution in 2001:

A: 0.3169
B: 0.0943
C: 0.0000
D: 0.5223
Sample size: 2170

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

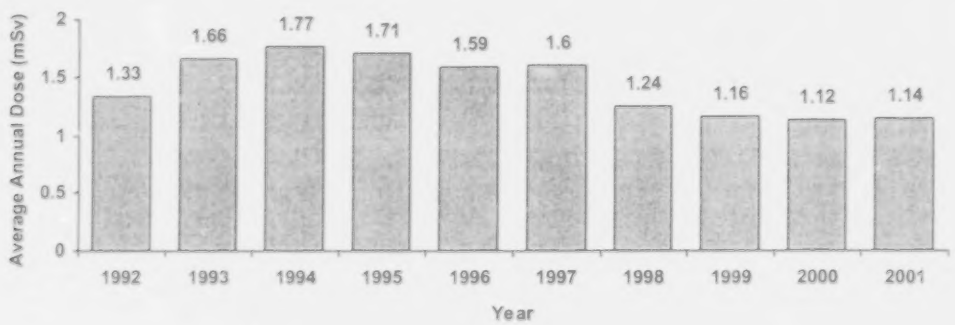


Table 4 (Cont'd)

Reactor - scientific/professional

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	1870	0.00	0.00	0
>0-1	358	94.47	0.26	26
>1-2	67	98.22	1.47	23
>2-5	93	312.17	3.36	16
>5-20	72	597.40	8.30	10
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	2460	1102.26	0.45	14
				Five year period 1997 - 2001
0	2844	0.00	0.00	0
>0-5	878	843.98	0.96	19
>5-25	231	2610.28	11.30	12
>25-100	39	1351.53	34.65	11
>100	0	0.00	0.00	0
Total	3992	4805.79	1.20	13

Parameters of the distribution in 2001:

A: 0.1036
B: 0.1015
C: 0.0195
D: 1.226
Sample size: 2460

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

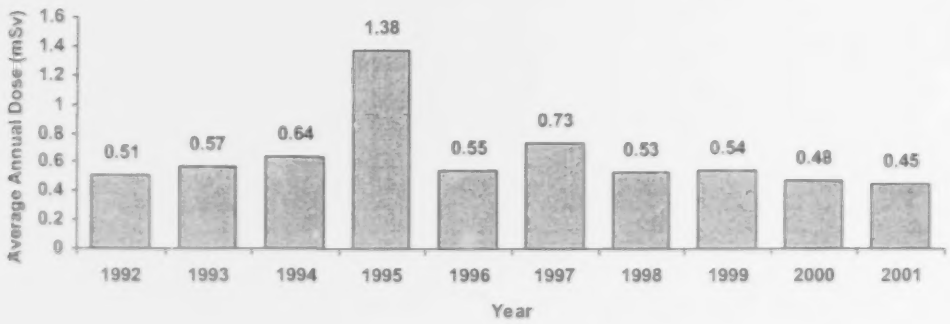


Table 4 (Cont'd)

Reactor - training

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	52	0.00	0.00	0
>0-1	6	1.90	0.32	25
>1-2	2	2.48	1.24	14
>2-5	2	6.79	3.40	3
>5-20	2	11.67	5.84	6
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	64	22.84	0.36	7
				Five year period 1997 - 2001
0	128	0.00	0.00	0
>0-5	38	33.14	0.87	19
>5-25	9	109.17	12.13	10
>25-100	1	47.86	47.86	7
>100	0	0.00	0.00	0
Total	176	190.17	1.08	11

Parameters of the distribution in 2001:

A: 0.0284
B: 0.1636
C: 0.0371
D: 1.2121
Sample size: 64

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

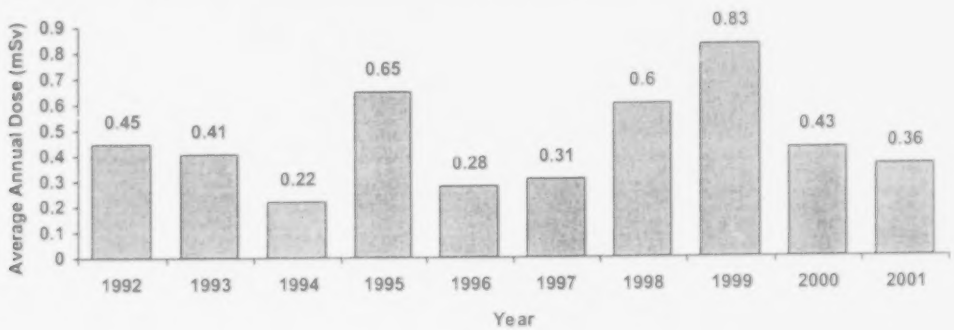


Table 4 (Cont'd)

Reactor - visitor

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2001
0	3828	0.00	0.00	0
>0-1	641	207.09	0.32	32
>1-2	182	270.05	1.48	22
>2-5	279	899.80	3.23	17
>5-20	188	1529.66	8.14	11
>20-50	6	136.93	22.82	4
>50	0	0.00	0.00	0
Total	5124	3043.53	0.59	15
				Five year period 1997 - 2001
0	6625	0.00	0.00	0
>0-5	1339	1654.51	1.24	19
>5-25	276	2743.70	9.94	10
>25-100	25	881.92	35.28	8
>100	0	0.00	0.00	0
Total	8265	5280.13	0.64	13

Parameters of the distribution in 2001:

A: 0.1166
B: 0.1041
C: 0.5411
D: 1.0336
Sample size: 5124

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

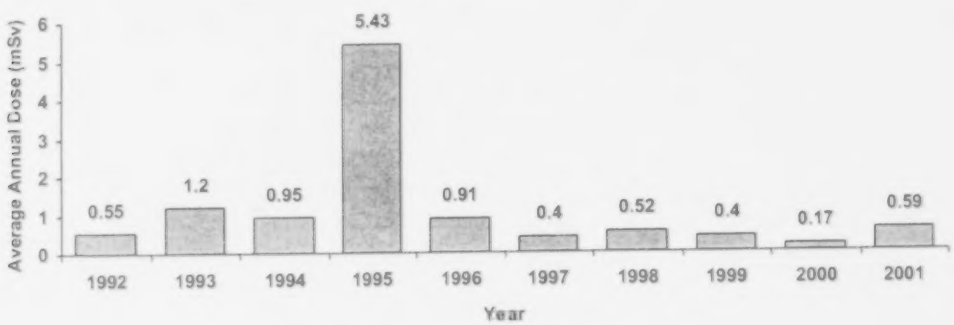


Table 4 (Cont'd)

Uranium mine electrician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	2	0.00	0.00	0
>0-1	1	0.30	0.30	0
>1-2	0	0.00	0.00	0
>2-5	0	0.00	0.00	0
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	3	0.30	0.10	0
				Five year period 1997 - 2001
0	6	0.00	0.00	0
>0-5	16	8.90	0.56	97
>5-25	0	0.00	0.00	0
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	22	8.90	0.40	97

Parameters of the distribution in 2001:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

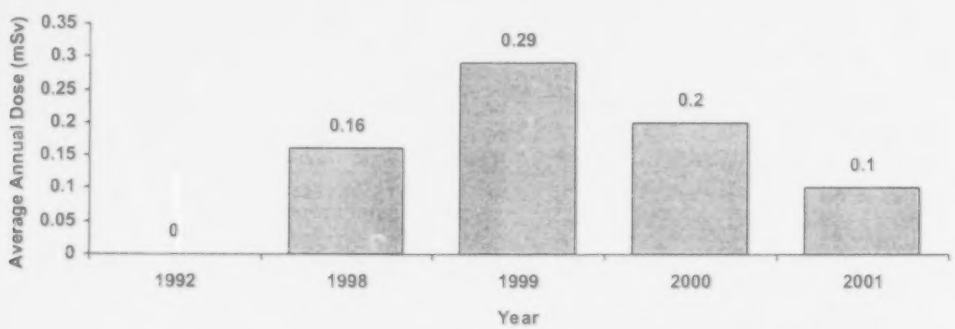


Table 4 (Cont'd)

Uranium mine mill maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	6	0.00	0.00	0
>0-1	66	31.30	0.47	44
>1-2	45	65.00	1.44	50
>2-5	42	126.00	3.00	54
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	159	222.30	1.40	51
				Five year period 1997 - 2001
0	18	0.00	0.00	0
>0-5	171	316.75	1.85	71
>5-25	103	1090.40	10.59	43
>25-100	8	224.80	28.10	20
>100	0	0.00	0.00	0
Total	300	1631.95	5.44	45

Parameters of the distribution in 2001:

A: 0
B: 0.6770
C: 0.0969
D: -0.7061
Sample size: 159

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

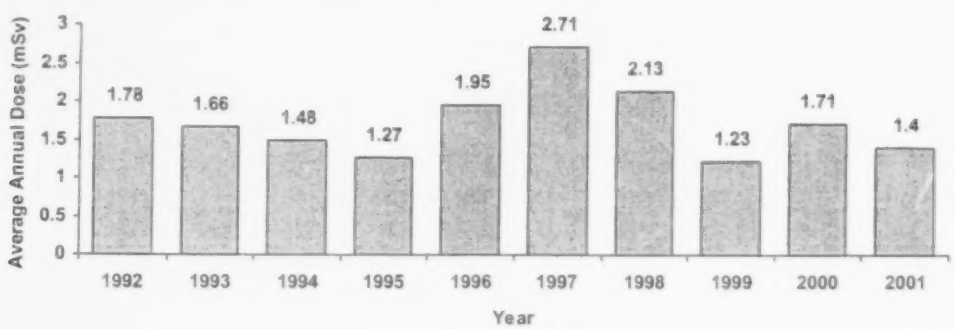


Table 4 (Cont'd)

Uranium mine mill worker

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	30	0.00	0.00	0
>0-1	58	20.55	0.35	67
>1-2	48	72.05	1.50	49
>2-5	91	284.55	3.13	45
>5-20	12	82.40	6.87	49
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	239	459.55	1.92	47
				Five year period 1997 - 2001
0	31	0.00	0.00	0
>0-5	225	376.10	1.67	59
>5-25	178	2078.00	11.67	46
>25-100	8	232.05	29.01	19
>100	0	0.00	0.00	0
Total	442	2686.15	6.08	45

Parameters of the distribution in 2001:

A: 0
B: 0.4288
C: 0.0406
D: -0.6305
Sample size: 239

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

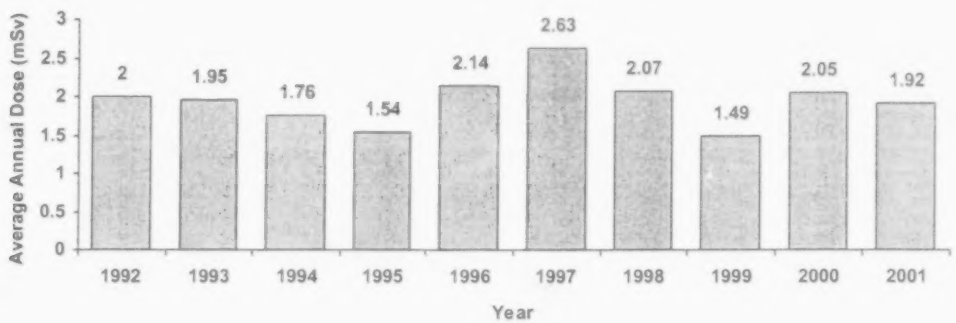


Table 4 (Cont'd)

Uranium mine nurse

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	12	0.00	0.00	0
>0-1	2	0.75	0.38	87
>1-2	0	0.00	0.00	0
>2-5	0	0.00	0.00	0
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	14	0.75	0.05	87
				Five year period 1997 - 2001
0	21	0.00	0.00	0
>0-5	16	10.05	0.63	59
>5-25	0	0.00	0.00	0
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	37	10.05	0.27	59

Parameters of the distribution in 2001:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

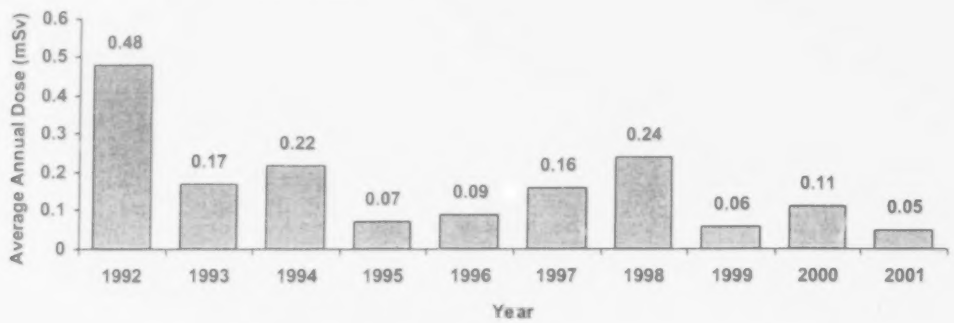


Table 4 (Cont'd)

Uranium mine office staff

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	101	0.00	0.00	0
>0-1	75	18.25	0.24	35
>1-2	1	1.25	1.25	84
>2-5	0	0.00	0.00	0
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	177	19.50	0.11	38
				Five year period 1997 - 2001
0	152	0.00	0.00	0
>0-5	231	163.35	0.71	62
>5-25	0	0.00	0.00	0
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	383	163.35	0.43	62

Parameters of the distribution in 2001:

A: 0
B: 1.7589
C: 0.0000
D: 0.6069
Sample size: 177

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

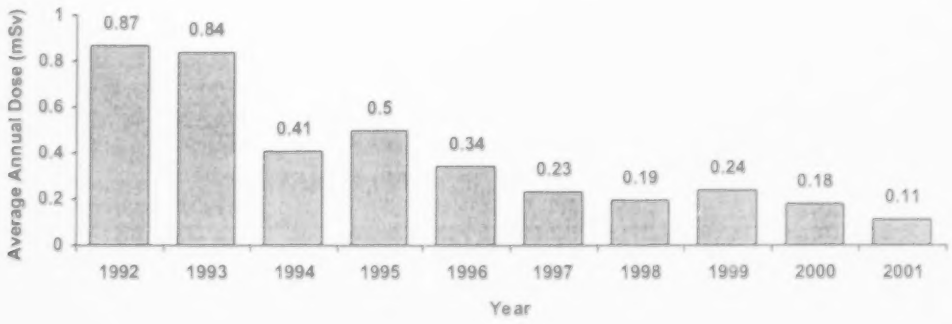


Table 4 (Cont'd)

Uranium mine support worker

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	45	0.00	0.00	0
>0-1	72	23.55	0.33	72
>1-2	23	34.30	1.49	37
>2-5	30	92.60	3.09	32
>5-20	6	45.65	7.61	21
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	176	196.10	1.11	35
				Five year period 1997 - 2001
0	89	0.00	0.00	0
>0-5	604	680.85	1.13	70
>5-25	120	1305.90	10.88	47
>25-100	8	258.25	32.28	35
>100	0	0.00	0.00	0
Total	821	2245.00	2.73	53

Parameters of the distribution in 2001:

A: 0.2185
B: 0.2160
C: 0.0348
D: 0.2792
Sample size: 176

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

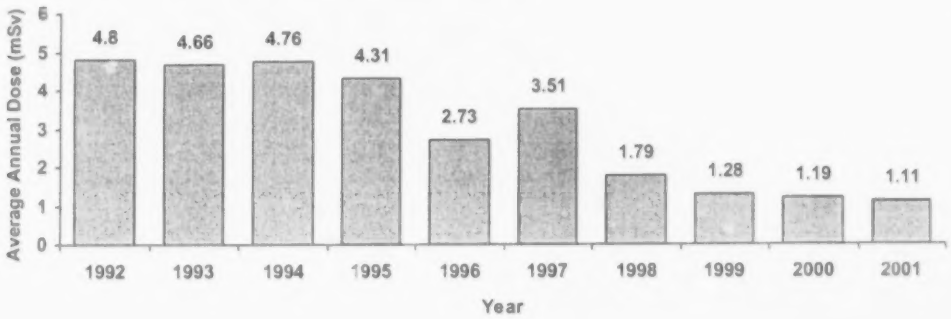


Table 4 (Cont'd)

Uranium mine surface maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	28	0.00	0.00	0
>0-1	124	45.55	0.37	57
>1-2	29	38.20	1.32	35
>2-5	7	18.80	2.69	60
>5-20	1	5.75	5.75	91
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	189	108.30	0.57	51
				Five year period 1997 - 2001
0	122	0.00	0.00	0
>0-5	368	409.75	1.11	63
>5-25	30	209.55	6.98	31
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	520	619.30	1.19	52

Parameters of the distribution in 2001:

A: 0.3331
B: 0.5059
C: 0
D: 0.3265
Sample size: 189

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

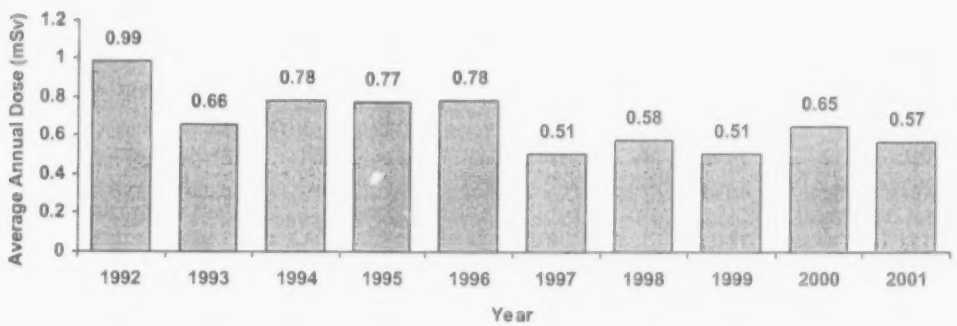


Table 4 (Cont'd)

Uranium mine surface miner

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	3	0.00	0.00	0
>0-1	10	5.15	0.52	63
>1-2	5	8.45	1.69	62
>2-5	29	87.55	3.02	54
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	47	101.15	2.15	55
				Five year period 1997 - 2001
0	47	0.00	0.00	0
>0-5	222	290.30	1.31	32
>5-25	43	307.10	7.14	40
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	312	597.40	1.91	36

Parameters of the distribution in 2001:

A: 0
B: 0.7002
C: 0.2639
D: -1.4431
Sample size: 47

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

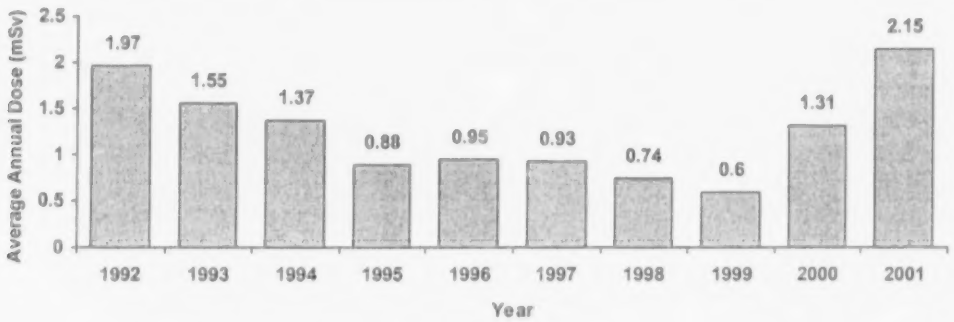


Table 4 (Cont'd)

Uranium mine surface personnel

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	78	0.00	0.00	0
>0-1	86	26.20	0.30	39
>1-2	24	34.30	1.43	57
>2-5	19	52.85	2.78	86
>5-20	1	6.45	6.45	92
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	208	119.80	0.58	68
				Five year period 1997 - 2001
0	114	0.00	0.00	0
>0-5	287	284.10	0.99	63
>5-25	24	167.20	6.97	64
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	425	451.30	1.06	64

Parameters of the distribution in 2001:

A: 0.0175
B: 0.4342
C: 0.0859
D: 0.4928
Sample size: 208

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

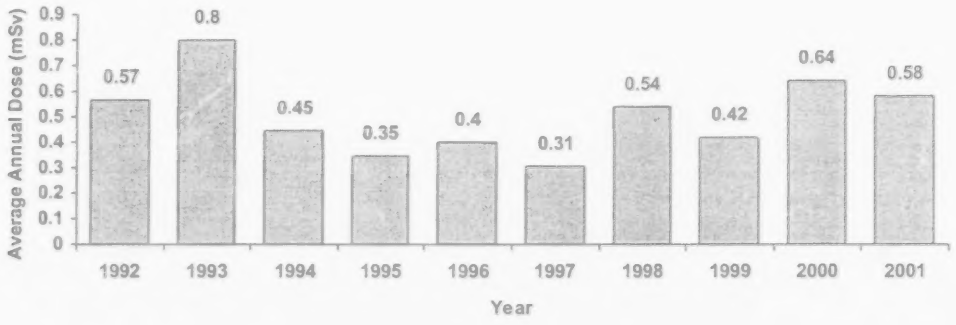


Table 4 (Cont'd)

Uranium mine surface support worker

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	209	0.00	0.00	0
>0-1	113	28.45	0.25	43
>1-2	10	16.20	1.62	45
>2-5	12	37.15	3.10	43
>5-20	1	6.20	6.20	65
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	345	88.00	0.26	45
				Five year period 1997 - 2001
0	332	0.00	0.00	0
>0-5	496	470.80	0.95	45
>5-25	29	236.65	8.16	36
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	857	707.45	0.83	42

Parameters of the distribution in 2001:

A: 0
B: 0.2611
C: 0.1276
D: 1.3448
Sample size: 345

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

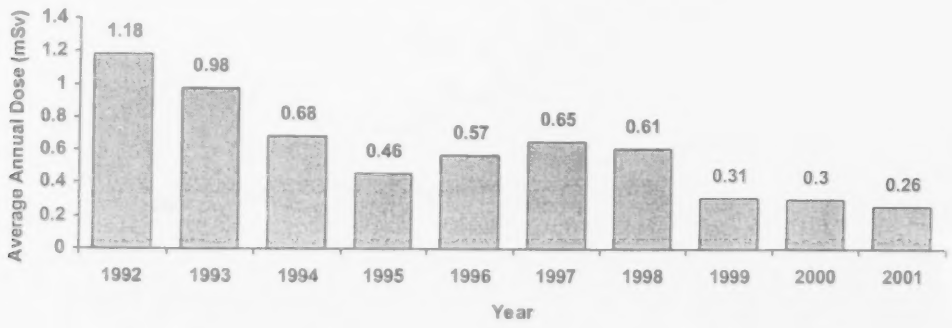


Table 4 (Cont'd)

Uranium mine underground maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	22	0.00	0.00	0
>0-1	80	32.25	0.40	76
>1-2	11	16.00	1.45	49
>2-5	2	4.50	2.25	38
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	115	52.75	0.46	64
				Five year period 1997 - 2001
0	27	0.00	0.00	0
>0-5	308	403.30	1.31	76
>5-25	32	280.30	8.76	64
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	367	683.60	1.86	71

Parameters of the distribution in 2001:

A: 0.3918
B: 0.8532
C: 0.00003
D: 0.2430
Sample size: 115

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

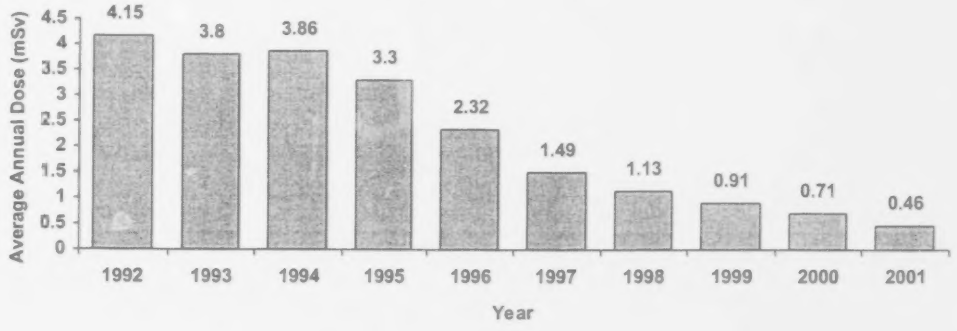


Table 4 (Cont'd)

Uranium mine underground miner

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	17	0.00	0.00	0
>0-1	54	20.95	0.39	70
>1-2	28	39.20	1.40	58
>2-5	37	120.30	3.25	41
>5-20	25	187.70	7.51	17
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	161	368.15	2.29	32
				Five year period 1997 - 2001
0	32	0.00	0.00	0
>0-5	401	664.60	1.66	68
>5-25	215	2545.90	11.84	49
>25-100	61	2272.70	37.26	26
>100	0	0.00	0.00	0
Total	709	5483.20	7.73	41

Parameters of the distribution in 2001:

A: 0.3118
B: 0.1675
C: 0
D: -0.2895
Sample size: 161

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

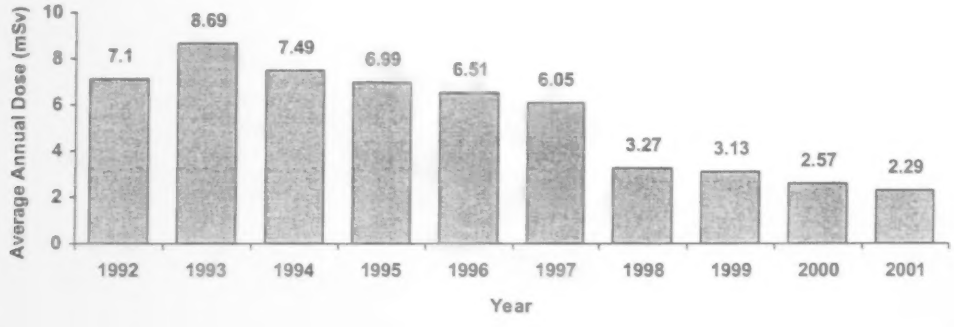


Table 4 (Cont'd)

Uranium mine underground personnel

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	22	0.00	0.00	0
>0-1	43	15.75	0.37	79
>1-2	5	6.80	1.36	65
>2-5	2	5.80	2.90	24
>5-20	1	6.80	6.80	13
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	73	35.15	0.48	54
				Five year period 1997 - 2001
0	184	0.00	0.00	0
>0-5	245	304.80	1.24	66
>5-25	53	478.80	9.03	51
>25-100	1	26.10	26.10	20
>100	0	0.00	0.00	0
Total	483	809.70	1.68	56

Parameters of the distribution in 2001:

A: 0.7039
B: 0.0283
C: 0
D: 1.1264
Sample size: 73

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001

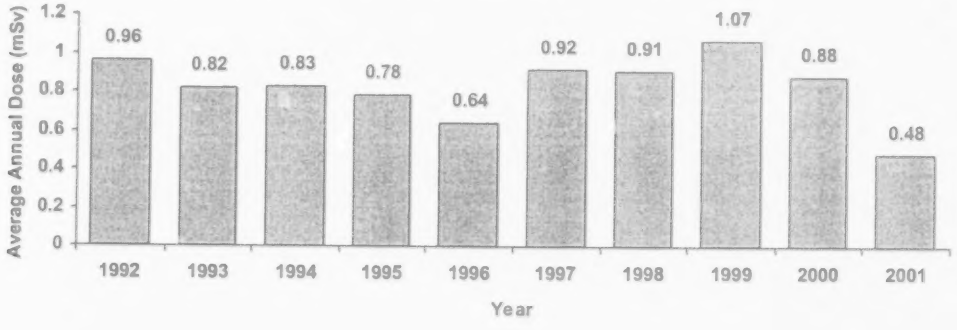


Table 4 (Cont'd)

Uranium mine visitor

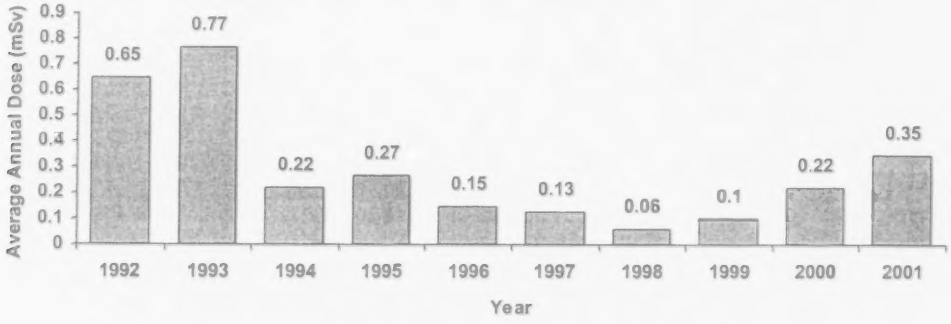
Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2001
0	39	0.00	0.00	0
>0-1	52	9.75	0.19	47
>1-2	3	5.30	1.77	2
>2-5	7	20.50	2.93	3
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	101	35.55	0.35	15
				Five year period 1997 - 2001
0	375	0.00	0.00	0
>0-5	512	162.15	0.32	53
>5-25	1	6.25	6.25	20
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	888	168.40	0.19	52

Parameters of the distribution in 2001:

A: 0
B: 0.3272
C: 0.0516
D: 0.9746
Sample size: 101

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1992 - 2001



Appendix

The new three component normal (TCN) distribution

The appendix explains how the data can be fitted to a statistical distribution, so that: (1) the sample of doses can be described by 5 quantities (the parameters of the distribution and sample size); and, (2) from these quantities, any dose statistic can be estimated, including any statistic not listed in this report, such as the 9-th decile.

Statistical distributions are defined by a probability density function, which is interpreted as follows:

The probability that a dose value lies between a and b equals

$$\int_a^b f(x)dx \quad ,$$

where f represents the probability density function and x assumes possible values of a random variable X which in our case represents the occupational dose.

The probability density function also contains a number of parameters, which determine the shape of the function. The distribution is defined by the mathematical formula for the density function, with the parameters as yet unspecified. Only when the parameters have been specified is the statistical model for the occupational dose defined. Parameters are adjusted to fit the data.

The TCN distribution has been designed to provide good fits especially to low dose distributions. Its probability density function is defined as:

$$f(x:A,B,C,D) =$$

$$\phi(A*\log(x) + B*x - C/x + D) *$$

$$(A/x + B + C/x^2) =$$

$$\phi(z) * (dz/dx)$$

where $\phi(t)$ denotes the standard normal probability density function $\exp(-t^2/2)/\sqrt{(2\pi)}$, and A, B, C and D are parameters of the distribution. In other words, the random variable:

$$Z = A*\log(X) + B*X - C/X + D$$

follows a standard normal distribution.

The parameters A, B and C are restricted to values >=0 and cannot all three be 0; there are no restrictions on the parameter D.

Special cases of this distribution arise when B and C are fixed to 0, and when just C is fixed to 0, while A>0; they are reparametrized versions of respectively the lognormal and hybrid lognormal distributions[4], which were used in previous reports.

If the parameters for the probability density function f are known, one can estimate any dose statistic. For example, the mean dose is estimated as

$$\int_0^\infty xf(x)dx$$

(since the dose values x are between 0 and infinity).

The variance of the dose is estimated as:

$$\int_0^\infty (x-\text{mean})^2 f(x)dx$$

and the standard deviation as the square root thereof.

The probability that a dose exceeds, for example, 50 mSv, is estimated as:

$$\int_{50}^\infty f(x)dx \quad .$$

The 95-th percentile is estimated as that dose value v for which:

$$\int_{v}^{\infty} f(x)dx = 95/100 .$$

The fraction of the collective dose due to doses exceeding 15 mSv is estimated as:

$$\frac{\int_{15}^{\infty} xf(x)dx}{\int_{0}^{\infty} xf(x)dx} .$$

The parameters are determined from the actual dose data. They are chosen to give the best "fit" with the sample of observed data, for which purpose there exists a variety of methods. The parameters in Table 4 have been estimated with a form of the Maximum Likelihood method. With this method, dose statistics can be estimated with the formulas given above, with the tabulated parameter values substituted for A, B, C and D. Instead of single dose values, small dose intervals and their frequencies (i.e. number of doses within the intervals) are used to determine the parameters. Doses recorded as 0 are assumed to have small positive values within the lowest dose interval. The resulting models will be valid for complete sets of workers' doses, not just doses recorded as positive as in previous reports.